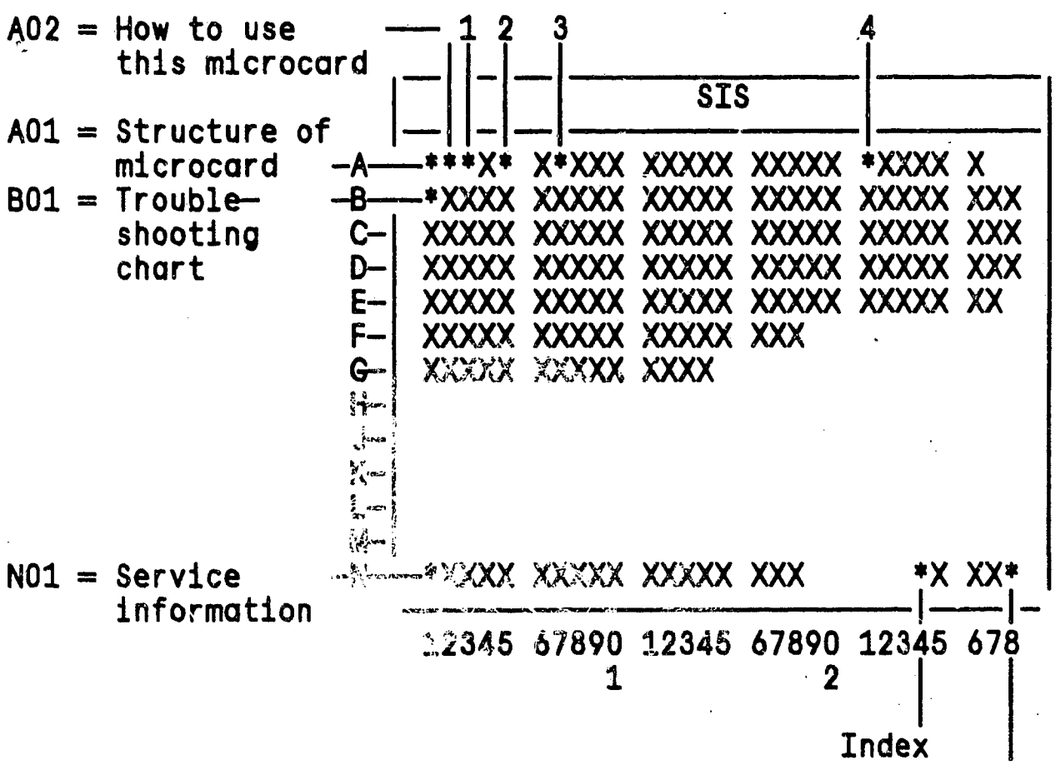
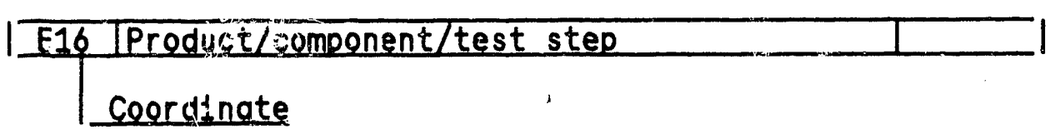
STRUCTURE OF THIS MICROCARD (BASIC INSTRUCTIONS)



1 = Special features
2 = Safety and precautionary measures
3 = Test equipment and tools
4 = Installation position of components

a. Read from left to right.

b. Title of micropicture (appears on each micropicture).



c. Limits of section



HOW TO USE THIS MICROCARD

Trouble-shooting instructions for system:

KE-Motronic, system version MK 1.1

Descriptions, photos, terminal designations and special features refer to the vehicle:

AUDI 80 with 2.0 l / 4-cyl. engine

Engine code letters 3A
Year of manufacture 09.87 ->

These basic instructions are comprehensive trouble-shooting instructions. They must not be used as vehicle-specific instructions. Caution! Descriptions and photographs may deviate from the vehicle-specific brief instructions.

Mandatory set values, terminal assignments and special features should be taken from the vehicle-specific brief instructions only. For brief instructions, see table of contents Microcard KFZ-00..

SPECIAL FEATURES

KE-Motronic, system version MK 1.1

This system with a joint control unit largely features the functions of the KE-3-Jetronic with an EI-K ignition system. In mechanical and hydraulic terms the injection section corresponds exactly to the KE-Jetronic.

The system features the following additional functions apart from the basic functions of injection and ignition:

* Lambda closed-loop control with adaptive basic mixture regulation (automatic compensation for basic errors).

* Idle speed control.

* Knock control.

* Electronically controlled tank ventilation.

* Self-diagnosis with fault storage.

SPECIAL FEATURES (CONTINUED)

Lambda closed-loop control with adaptive basic mixture regulation:

The KE-Motronic is a system with learning capability, i.e. changing environmental conditions, which may have a negative influence on mixture preparation under certain circumstances, are recognized and automatic compensation is provided.

Such changes in environmental conditions may for example be:

* Change in density of air (high altitude).

* Changes in quality (e.g. alcohol content) of fuel.

* Leakage air in intake system.

* Changes in engine and mixture preparation system with increasing mileage (drift).

Following repairs (e.g. elimination of considerable quantities of leakage air) the engine may therefore temporarily exhibit poor running behavior after starting which does however become normal again after a brief period or possibly after a short journey under load.

SPECIAL FEATURES (CONTINUED)

Tank ventilation system:

The fuel vapors occurring in the fuel tank are collected in an activated carbon filter. When the engine is running, it draws off the fuel vapors. A pulsed tank ventilation valve installed between the activated carbon filter and the intake manifold meters the fuel vapors as supplied.

The variable on/off ratio is output by the control unit as a function of the engine operating status and thus determines the opening cross-section of the tank ventilation valve. Excessive changes to the mixture are thus avoided.

The pulsed tank ventilation valve is preceded by a second valve for switching the tank ventilation. This valve is open when the engine is running and closed immediately once the ignition is switched off. Run-on (dieseling) for example caused by fuel vapors from the activated carbon filter is thus prevented.

SPECIAL FEATURES (CONTINUED)

Self-diagnosis:

Self-diagnosis takes the form of a flashing code. For this purpose the Californian model features an indicator lamp on the instrument panel (carb. lamp with engine symbol).

Other models are provided in the area of the KE mixture-control unit with a test connection to which a test lamp (max. 2 W) is connected as diagnosis lamp.

Diagnosis is initiated in all models by inserting a fuse in the socket on the housing of the electric-fuel-pump relay.

Faults occurring when driving are stored in the fault memory of the control unit. Exhaust and safety-related faults (carb. faults) are continuously indicated by the diagnosis lamp when they occur.

The fault memory for carb. faults must be reset following fault correction.

Other faults which can be detected by the control unit are stored in a further fault memory. Storage is retained even after the ignition has been switched off, but is automatically cancelled when the engine is restarted.

SAFETY AND PRECAUTIONARY MEASURES

Be sure to observe safety and precautionary measures so as to avoid risk to persons and to prevent damage to the engine, trigger boxes, control units or the ignition system.

CAUTION!
High-energy ignition system with dangerous high and low voltages!

Touching live parts or terminals may be highly dangerous (both on the primary and secondary sides).

For the compression test, detach the pump relay in order to prevent undesired injection by the injection valves.

Do not short-circuit ignition coil term. 1 to ground (e.g. for shutting down the engine). The ignition coil and possibly the control unit would be destroyed.

Never connect the positive terminal of the battery to ignition coil term.1. The control unit would be destroyed.

When fitting an alarm system, pay attention to the directions in the installation instructions for Jetronic vehicles or SIS microcard ALL 500. Ensure that there is no interference with the alarm relay by external fields (e.g. from ignition cables), causing the relay to respond incorrectly.

SAFETY AND PRECAUTIONARY MEASURES (CONTINUED)

Never start engine without battery securely connected (battery terminals tightened). Do not disconnect battery from vehicle electrical system with engine running.

Do not use a fast charger for starting the engine.
Provide starting assistance only with second 12 V battery and jump leads.
Caution! Owing to non-standardized requirements of vehicle manufacturers with regard to electronic products, we advise against using a 24 V battery for starting assistance.

When charging the battery in the vehicle or providing starting assistance, follow the operating instructions for the fast charger as well as instructions of the vehicle manufacturer.

Disconnect battery from vehicle electrical system before charging or fast-charging.

Incorrect polarity of the supply voltage, e.g. through incorrect connection of the battery or ignition coil, may lead to the destruction of a control unit.

Do not connect or disconnect wiring-harness plugs from control units or trigger boxes with the ignition on.

Remove control units at temperatures above + 80° C (paint-drying installation).

Remove control units before carrying out electric welding work.

SAFETY AND PRECAUTIONARY MEASURES
(CONTINUED)

Important information concerning work on KE-Motronic

Should any fuel connections be detached or parts removed - including work on the vacuum system - use is always to be made of new gaskets when reconnecting or re-attaching.

Ensure maximum cleanliness when working on the KE-Motronic. Fuel connections are to be cleaned thoroughly on the outside before detaching them.

When performing tests with the electric fuel pump running, never lift the sensor plate of the air-flow sensor as this will cause fuel to be injected via the injection valves. This may lead to extremely serious engine damage when subsequently starting the engine.

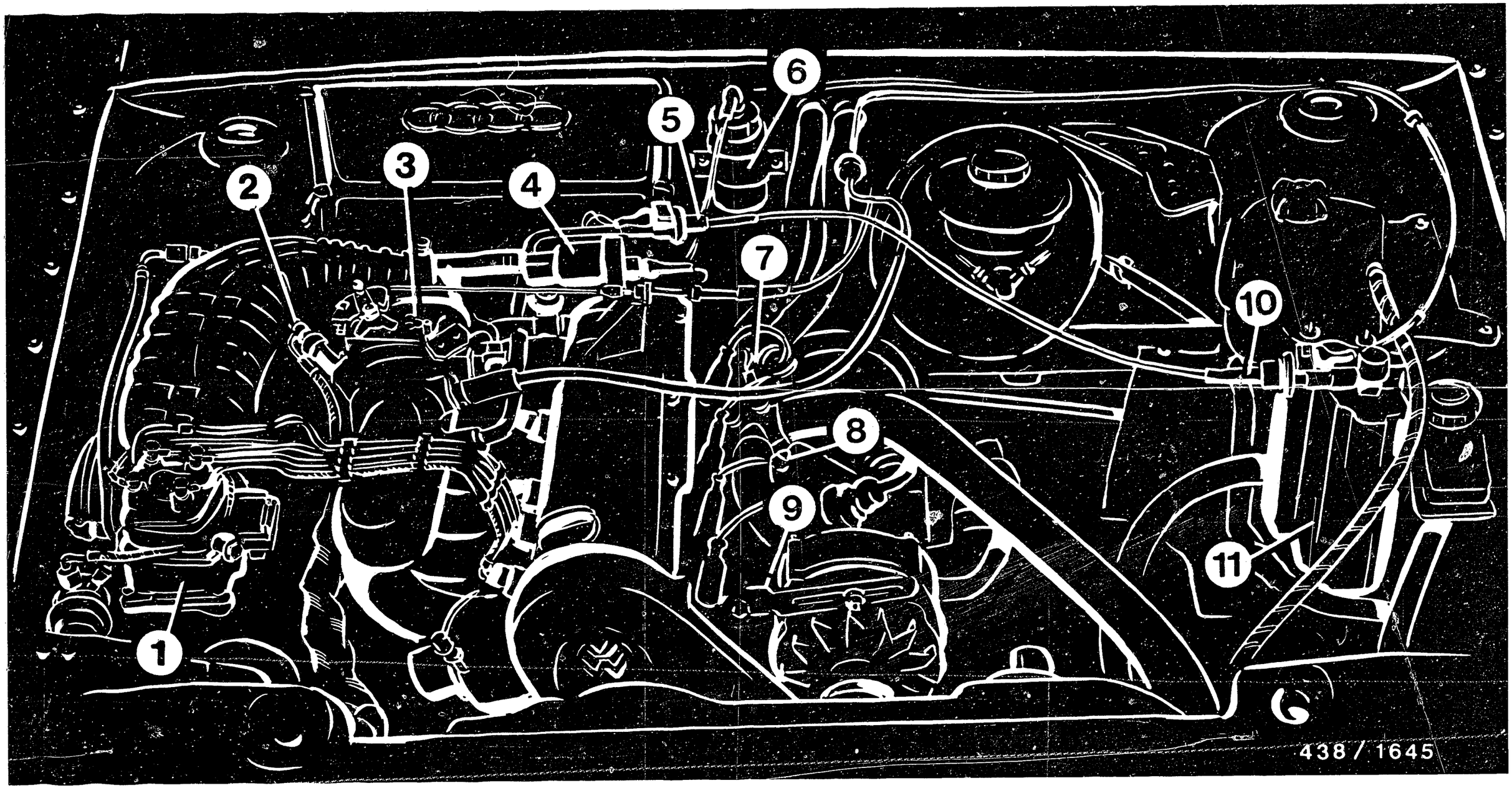
TEST EQUIPMENT AND TOOLS

Description	Part no.
Motortester e. g. MOT 201 MOT 300 MOT 400	0 684 000 201 0 684 000 300 0 684 000 400
Exhaust-gas analyzer e. g. Ett 008.02 Ett 008.03	0 684 100 802 0 684 100 803
Multimeter (internal resistance min. 20 k Ω /V)	commercially avail. e. Bg Metrawatt GmbH Type MA2H or Fluke Multimeter 75
Pressure tester for testing all fuel pressures and for leak test on system.	KDJE-P 100
Connecting-parts sets	KDJE-P 100/10 KDJE-P 100/11
Valve tester for testing injection valves.	KDJE-P 400
Test fuel Bosch order designation Bosch white spirit can be obtained in 5-liter cans from: Oskar Gnamm & Co D-7531 Kämpfelbach-Bilfingen	white spirit VS 14 942-CH
Tester for delivered-quantity comparison. For comparative measurement of fuel deliveries from the individual outlets of the fuel distributor.	KDJE-P 200

TEST EQUIPMENT AND TOOLS (CONTINUED)

Designation	Part No.
4 adapter sleeves For connecting measuring device for comparing delivery to injection valves with air shrouding sleeves	KDJE-P 200/19
4 adapter leads	KDJE-P 200/25
Adjusting wrench For adjusting exhaust.	KDEP 1035
Graduate, capacity approx. 1.5 liters For measuring delivery of electric fuel pump.	Commercially available
4 test leads (2 packs) For connecting multimeter to components and connector.	KDZS 0004
4 test leads (2 packs) For connecting multimeter to components and connector.	KDUM 0008
1 test lead For connecting motortester to frequency valve	1 684 463 093
1 graduated disc For adjusting full-load throttle-valve switch.	KDJE 7462
Mounting paste VS 14016 Ft For fitting lambda sensor.	5 964 080 112
1 battery 1.5 V (unicell) For simulating lambda sensor voltage.	Commercially available

For production reasons: continued on the following coordinate.



1 = Mixture-control unit
2 = Start valve
3 = Throttle-valve assembly with throttle-valve switch, full load (top) and idle (bottom, not visible in picture)
4 = Idle actuator
5 = Switching valve for tank ventilation
6 = Ignition coil with trigger box, output stage
7 = Ignition distributor
8 = Temperature sensor (engine)
9 = Knock sensor, on engine block, covered by alternator
10 = Tank ventilation valve (pulsed)
11 = Activated carbon filter

INSTALLATION POSITION OF COMPONENTS

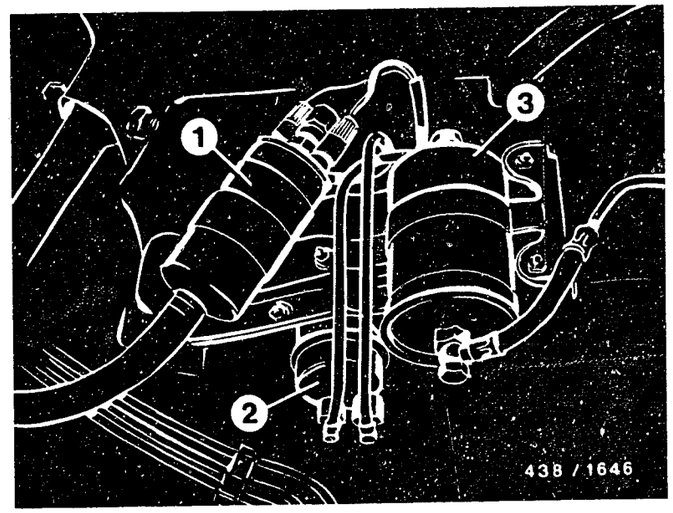
A13 — ⟹

A14 — ⟺

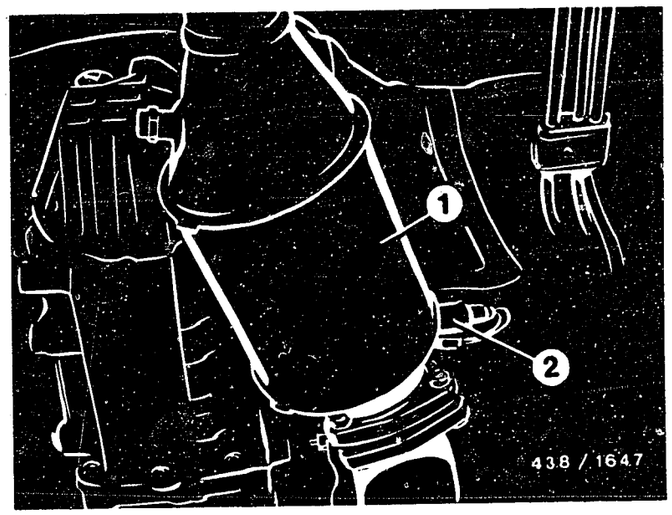
INSTALLATION POSITION OF COMPONENTS (CONTINUED)

Fuel supply components; on right on underside of vehicle, in area in front of rear axle.

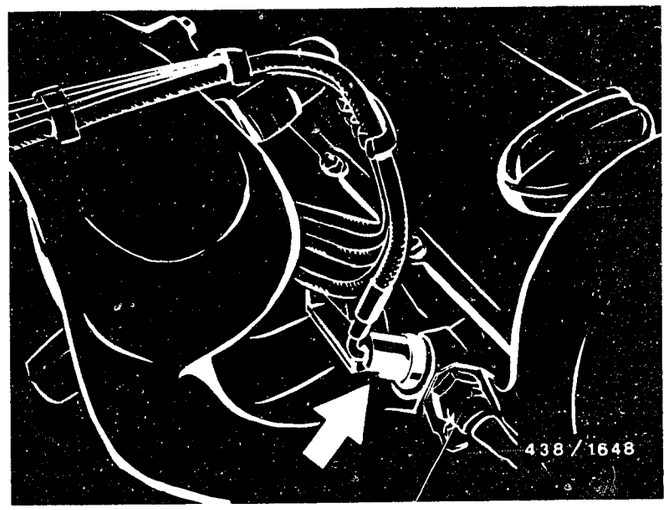
1 = Electric fuel pump
2 = Fuel accumulator
3 = Fuel filter



Catalytic converter (1) and lambda sensor (2), on right on underside of vehicle, in area behind rear axle.



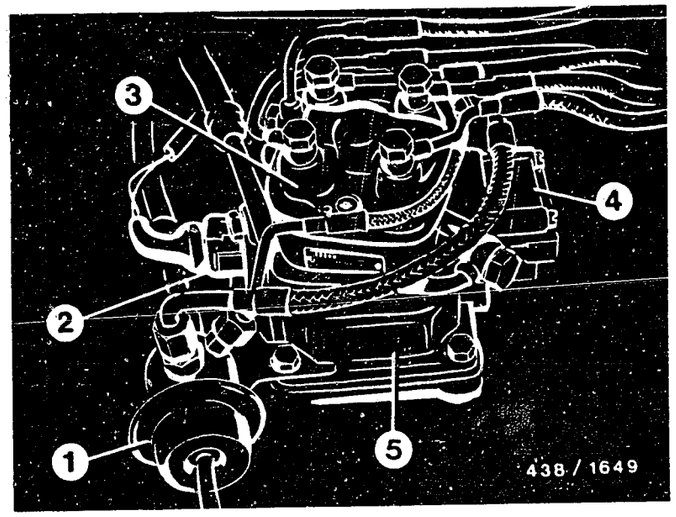
Injection valves (arrow cyl. 1), inserted in holes in intake-manifold flanges and secured in pairs by means of holders.



INSTALLATION POSITION OF COMPONENTS (CONTINUED)

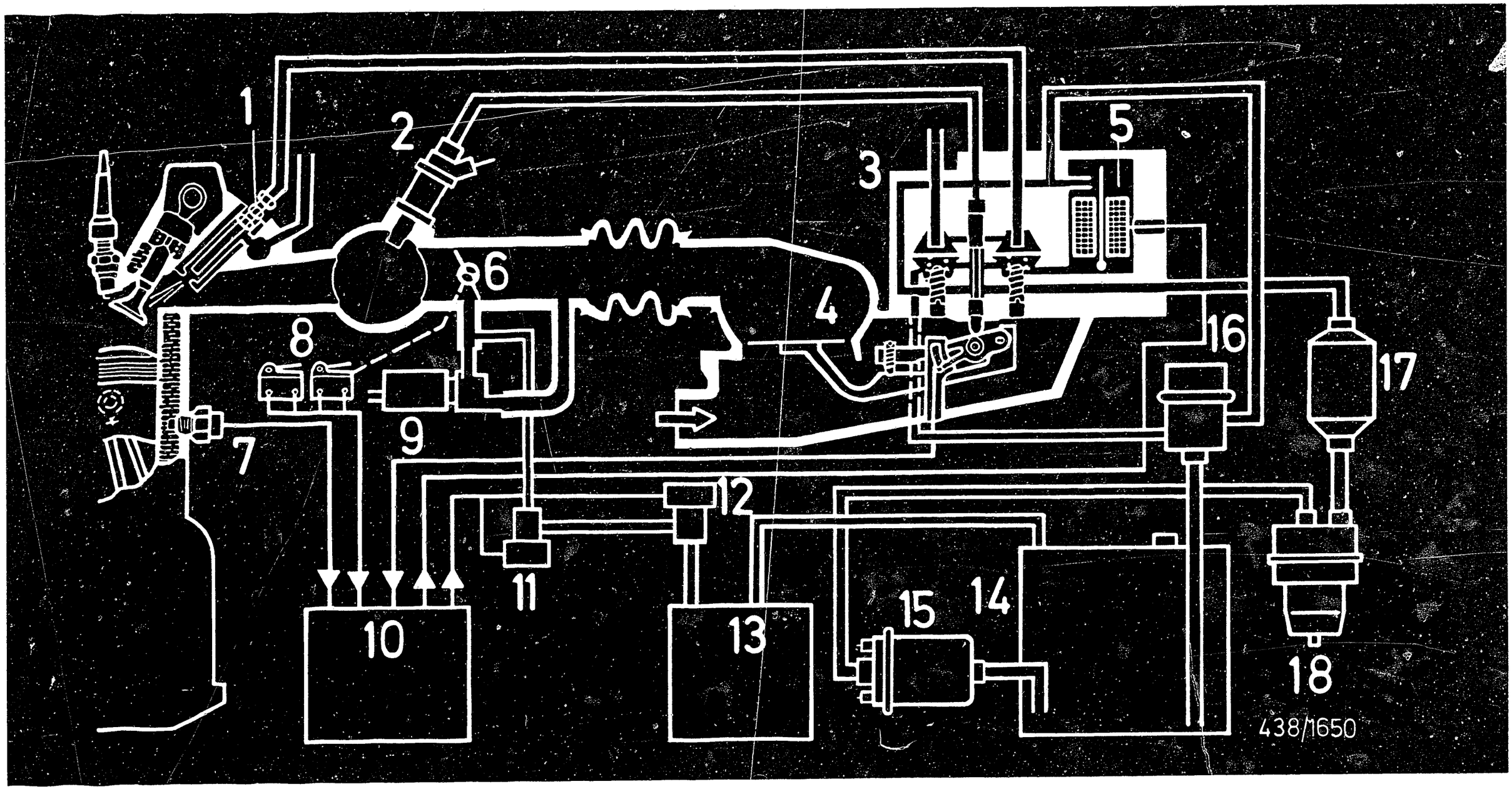
Components of mixture-control unit.

1 = Diaphragm pressure regulator (primary pressure)
2 = Air-flow-sensor potentiometer
3 = Fuel distributor
4 = Pressure actuator
5 = Air-flow sensor



The KE-Motronic control unit is located above the passenger-side footwell between bulkhead and vent duct.

Removal: remove facing from glove compartment. Press locking pin towards bulkhead and pull out control unit downwards.



1 = Injection valve
2 = Start valve
3 = Fuel distributor
4 = Air-flow sensor
5 = Pressure actuator
6 = Throttle valve
7 = Temperature sensor (engine)
8 = Throttle-valve switch (idle/full load)
9 = Idle actuator
10 = Control unit
11 = Switching valve for tank ventilation
12 = Tank ventilation valve (pulsed)
13 = Activated carbon filter
14 = Fuel tank
15 = Electric fuel pump
16 = Pressure regulator (primary pressure)
17 = Fuel filter
18 = Fuel accumulator

DIAGRAM OF FUEL LINES AND AIR GUIDANCE, KE-MOTRONIC

A19 ⟹
A20 ⟸

HOW TO USE TROUBLE-SHOOTING CHART AND TROUBLE-SHOOTING PROGRAM

The TROUBLE-SHOOTING CHART starts on Coordinate B03 and contains customer complaint (fault symptom) with several possible causes (component faults) in each case as well as coordinate references for detailed trouble-shooting. If no coordinate reference is given, it is a cause for which test instructions are not required.

If the customer complaint is clear, proceed with trouble-shooting in the given order of possible causes, one after the other and step by step.

Trouble-shooting should always start with the self-diagnosis (if available) or with the universal test adapter (if provision is made). Only then continue with the trouble-shooting chart.

If the customer complaint is not clear, check all the causes given in the trouble-shooting chart. In order to prevent possible incorrect measurements, check all causes in the order given (because of the interlinking of test steps).

HOW TO USE TROUBLE-SHOOTING CHART AND TROUBLE-SHOOTING PROGRAM (CONTINUED)

The TROUBLE-SHOOTING PROGRAM contains all system and component checks mentioned in the trouble-shooting chart. It is divided into three rows of boxes.

The left-hand column contains test instructions and set values.
The center column contains instructions on trouble-shooting and fault rectification. The right-hand column contains the illustrations/terminal diagrams belonging to the text, with explanations.

If the questions in the left-hand column can be answered clearly with "yes", continue trouble-shooting with the next box down.

If the answer to the question is "no", branch to the center column and carry out the tests in the order given there.
After the fault has been rectified, repeat the test as a check.

TEST CONDITIONS:

- Battery fully charged
- Engine mechanically O.K.
 (e.g. compression, valve clearance etc.)
- Engine at operating temperature approx. +80°C (if necessary)
- All connectors of wiring harness correctly seated

TROUBLE-SHOOTING CHART

Customer complaint (fault symptoms)

1. Starting motor operates, engine fails to start or starts only with difficulty.	2. Engine starts but then dies.	3. Idle problems (engine speed, exhaust gas).	4. Poor throttle take-up, flat spot during acceleration.	5. Engine missing (ignition, injection).	6. Maximum engine power/top speed not reached.	7. Fuel consumption too high.	8. Engine running on.	9. Engine pinging/knocking.	10. Engine overheating.	11. Fault lamp.	Cause (component fault)	Coord.
*	*	*	*	*	*	*	*	*	*	*	Self-diagnosis	B06
*		*	*		*						Intake system	D17
*	*	*	*		*			*	*		Voltage supply Control unit	G13
*	*			*	*						Electric fuel pump	G17
*	*	*	*				*				Air-flow sensor	G23
*		*				*					Start valve	H09
*	*			*	*						Primary pressure	H13
*	*	*	*	*	*	*					Differential pressure	H17
*											Fuel system leakage	J05
*	*	*	*	*	*		*				Injection valves	J15
*	*	*	*		*	*					Fuel distributor	J27
*		*			*						Throttle valve	K11

B03 — ⟹

TROUBLE-SHOOTING CHART (CONTINUED)

Customer complaint (fault symptoms)

1. Starting motor operates, engine fails to start or starts only with difficulty.	2. Engine starts but then dies.	3. Idle problems (engine speed, exhaust gas).	4. Poor throttle take-up, flat spot during acceleration.	5. Engine missing (ignition, injection).	6. Maximum engine power/top speed not reached.	7. Fuel consumption too high.	8. Engine running on (dieseling).	9. Engine pinging/knocking.	10. Engine overheating.	11. Fault lamp.	Cause (component fault)	Coord.
*	*	*	*		*	*					Temperature sensor (engine)	D27
		*	*								Throttle-valve switch (idle)	C09
					*			*	*		Throttle-valve switch (full load)	C17
		*	*		*						Lambda closed-loop control	E03
*	*	*	*			*					Exhaust adjustment	L23
		*									Idle-speed control	L23
*											Starting enrichment	K15
	*										Post-start enrichment	K15
	*	*	*								Warm-up enrichment	K15
			*								Acceleration enrichment	K15
			*		*				*		Full-load enrichment	K15
						*					Overrun cutoff	K15
							*				Tank ventilation system	K25

B04 — ⟺

TROUBLE-SHOOTING CHART (CONTINUED)

Customer complaint (fault symptoms)

1. Starting motor operates, engine fails to start or starts only with difficulty.	2. Engine starts but then dies.	3. Idle problems (engine speed, exhaust gas).	4. Poor throttle take-up, flat spot during acceleration.	5. Engine missing (ignition, injection).	6. Maximum engine power/top speed not reached.	7. Fuel consumption too high.	8. Engine running on (dieseling).	9. Engine pinging/knocking.	10. Engine overheating.	11. Fault lamp.	Cause (component fault)	Coord.
*			*								Ignition, high-tension end	L07
*			*								Ignition coil	L09
*	*										Firing order	
*											Voltage, magnetic pulse generator	B23
*											Function, magnetic pulse generator	B23
*											Control function, ignition	L11
*											Voltage, trigger box	L13
*											Primary signal	L15
			*								Voltage, ignition coil	L17
*											Ignition distributor - installed setting	L19
*					*	*	*	*	*	*	Basic ignition setting	L21

HOW TO USE SELF-DIAGNOSIS, SELF-DIAGNOSIS TEST TABLE AND TROUBLE-SHOOTING PROGRAM

This vehicle is equipped with a control unit which has a self-diagnosis feature. Therefore, start trouble-shooting with the self-diagnosis.

How to activate the self-diagnosis is described starting on Coordinate B09. The self-diagnosis test table starting on Coordinate B13 contains:
- Fault indication (flashing code)
- Components or system functions under test
- Test instructions/test conditions
- Connection terminals
- Set-value specifications
- Coordinate references for trouble-shooting and fault rectification in the subsequent self-diagnosis trouble-shooting program.

HOW TO USE SELF-DIAGNOSIS, SELF-DIAGNOSIS TEST TABLE AND TROUBLE-SHOOTING PROGRAM (CONTINUED)

The self-diagnosis trouble-shooting program starting on Coordinate ■ is divided into 3 columns.

The left-hand column contains test instructions and set values.

The center column contains instructions on trouble-shooting and fault rectification.

The right-hand column contains the illustrations/ terminal diagrams belonging to the text, with explanations.

If the questions in the left-hand column can be be answered clearly with "yes", continue trouble-shooting with the next box down.

If the answer to the question is "no", branch to the center column and carry out the tests in the order given there.
If the self-diagnosis indicates a fault, but no system or component fault has been found during trouble-shooting, try replacing the control unit.

HOW TO USE SELF-DIAGNOSIS, SELF-DIAGNOSIS TEST TABLE AND TROUBLE-SHOOTING PROGRAM (CONTINUED)

Following elimination of fault, cancel fault memory and repeat test as a check.
Note: there are two fault groups each with their own memory:

* Exhaust and safety-relevant faults (carb. faults). These are indicated continuously when they occur.

 Indicator in California model: Carb. lamp in instrument panel (engine symbol)

 Indicator in other models (without carb. lamp): test lamp which is connected to special test connection (in area of mixture-control unit).

* Other component faults which are detected by the control unit, but which are not indicated when they occur.

Cancelling of both memories: see section "Activation of self-diagnosis", following coordinate.

If the self-diagnosis indicates no further system-specific faults and the customer complaint (fault symptom) has still not been eliminated, trouble-shooting must be continued with the trouble-shooting chart as of coordinate B03.

ACTIVATION OF SELF-DIAGNOSIS

To enable the control unit to detect existing faults, a test drive must be carried out under the following conditions for at least 5 minutes before activating (triggering) the self-diagnosis:

* Coolant temperature at least 80° C.
* Engine speed must exceed 3000 min $^{-1}$ at least once.
* Accelerator must be fully depressed at least once.

Following the test drive the engine must be allowed to run at idle for at least a further 2 minutes.

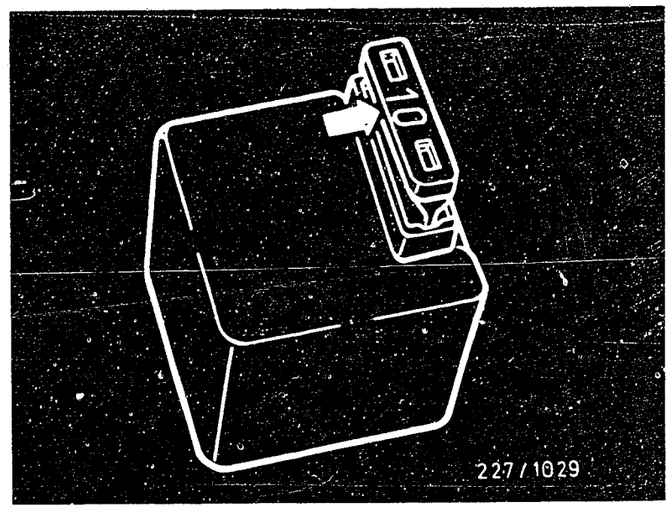
The self-diagnosis can now be activated with the engine running (idling speed) as well as with the engine stopped and the ignition switched on.

If the engine will not run, it must be cranked for at least 6 seconds to enable the control unit to detect existing faults.
Do not subsequently switch off ignition.
Then activate self-diagnosis.

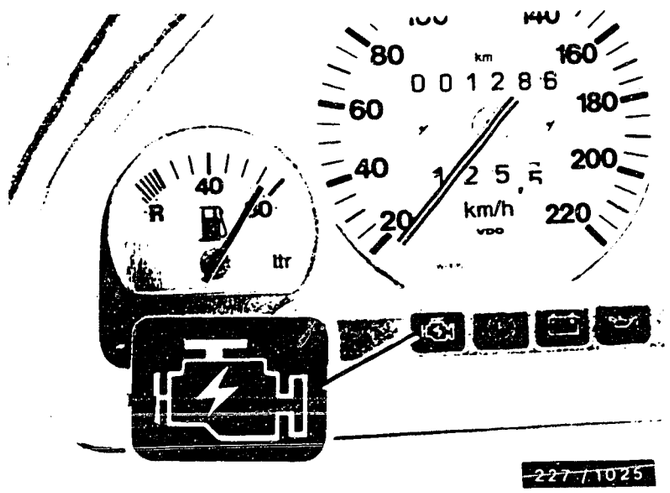
To activate self-diagnosis, insert a fuse for at least 4 seconds into the socket provided for this purpose on the housing of the electric-fuel-pump relay (top picture, arrow).

Flashing-code indication by means of diagnosis lamp:

* California model: carb. lamp in instrument panel (instrument cluster, bottom picture).
* Other models (without carb. lamp):
 Connect test lamp (max. 2 W) at test connection (in area of mixture-control unit) to battery +.



Arrow = Electric-fuel-pump relay jumped with fuse



ACTIVATION OF SELF-DIAGNOSIS (CONTINUED)

Fault output commences with a 2.5 s pulse.
It is followed by a pause of the same duration. This in turn is followed by the flashing code in 4 flashing pulse groups with up to 4 flashing pulses in each case. The fault code is repeated until the fuse is inserted again at the EFP relay for at least 4 seconds. For separation purposes, there is a 2.5 s flashing pulse between the repetitions.

Once all stored faults have been output, the flashing code " 0 0 0 0 " appears following renewed activation.
The diagnosis lamp flashes with a 2.5 s frequency.

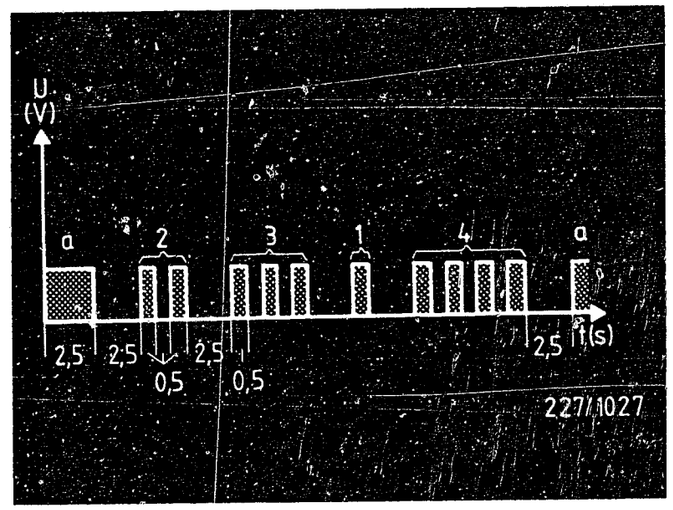
Completion of self-diagnosis is achieved by inserting the fuse again, by briefly increasing engine speed to in excess of 2500 min^{-1} or by switching off the ignition.

The fault memories must be cancelled before the control unit can store any further faults:

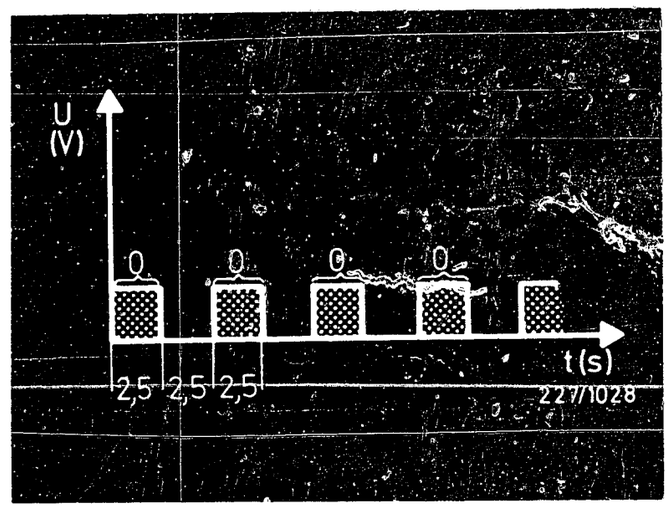
* The fault memory for component faults is reset every time the engine is started.

* Resetting of carb. fault memory:

 - Switch off ignition.
 - Insert fuse at EFP relay.
 - Switch on ignition after 4 seconds (diagnosis lamp lights).
 - Remove fuse after at least a further 4 seconds.
 Flashing code 0 0 0 0 is output.
 - Insert fuse again for at least 5 seconds.
 The diagnosis lamp must then light up continuously.



N O T E :
Grid area means fault lamp "ON".
a = start signal (commencement of transmission of corresponding flashing code)



SELF-DIAGNOSIS TEST TABLE

Fault indication Flashing code	Testing of component/function	Test instructions/ Test conditions	Termi-nals	Set values	Coord.
1 1 1 1	Control unit	This fault is indicated by the diagnosis lamp lighting up continuously when driving. Replace control unit without further testing.	—	———	B21
2 1 1 3	Magnetic pulse generator defective or open-circuit in lead of control unit of magnetic pulse generator	Engine cannot be started. Switch on ignition. Voltage measurement at cable connector, ignition distributor: Check generator signal (idle speed):	3 1 (+)(-) 2 1	Min. 10 V Rectangular pulse	B23
	Sensor plate of air-flow sensor sticks in off position	It may be possible to start engine. Check centering and freedom of movement of sensor plate.	— —	———	B23
2 1 2 1	Throttle-valve switch, idle or lead defective	Throttle-valve switch, idle permanently closed. Lead to CU-terminal 28 short-circuited to ground. Incorrect switch setting. Resistance measurement at connector: throttle valve, closed: throttle valve, open: Switching-point setting:	 1 2	 Approx. 0 Ω Infinity Ω 0.15 ... 0.5 mm	C09
2 1 2 3	Throttle-valve switch, full load or lead defective	Throttle-valve switch, full load permanently closed. Lead to control-unit terminal 31 short-circuited to ground. Incorrect setting Resistance measur ent at connector: throttle valve, closed: throttle valve, open: Switching-point setting:	 2 3	 Infinity Ω Approx. 0 Ω 8 ... 12° before full load	C17

B13 — ⟹

B14 — ⟺

SELF-DIAGNOSIS TEST TABLE (CONTINUED)

Fault indication Flashing code	Testing of component/function	Test instructions/ Test conditions	Termi-nals	Set values	Coord.
2 1 4 1	Knock control limit reached	If engine knocking occurs, ignition angle is retarded by a certain amount and then advanced again slowly. Diagnosis lamp lights up during period of maximum retardation. Test/correct basic ignition setting. Test value: Setting: Idle-speed adjustment incorrect. Test: Other possible causes: fuel quality, damage to shielding lead of knock sensor, engine damage.	— — — —	 See brief instruc. See brief instruc. See brief instruc.	C25
2 1 4 2	Knock sensor defective or open-circuit in lead or contact resistance	Fault detection as of engine speed approx. 2650 min $^{-1}$ Following delay period, diagnosis lamp lights up continuously until engine is switched off. Check for open-circuit in leads from control unit to plug connection of knock sensor: Test connector of knock-sensor lead for short-circuit to ground: Tightening torque, knock sensor:	 6 1 8 2 8 3 1 2 	 Approx. 0 Ω Approx. 0 Ω Approx. 0 Ω Infinity Ω See brief instruc.	D09
2 2 3 1	Idle speed control outside working range	Possible causes: basic setting of throttle valve. Adjustment: intake system (e.g. leakage air). Test: incorrect basic ignition setting. Test value:	 — — — — — —	 — — — — See brief instruc.	C13

SELF-DIAGNOSIS TEST TABLE (CONTINUED)

Fault indication Flashing code	Testing of component/function	Test instructions/ Test conditions	Terminals	Set values	Coord.
2 2 3 2	Potentiometer at air-flow sensor defective or open-circuit in lead	Voltage measurements at cable connector, potentiometer (with auxiliary leads). Switch on ignition.			D21
		Supply:	1 3	4.35 ... 5.35 V	
		Signal (raise sensor plate):	2 3	Voltage increase	
			(+) (-)		
		Detach control-unit connector and check leads 8, 23 and 26 to potentiometer connector for:			
		* open-circuit:	8 3	Approx. 0 Ω	
			23 2	Approx. 0 Ω	
			26 1	Approx. 0 Ω	
		* short-circuit to ground:	8,23,26	Infinity Ω	
2 3 1 2	Temperature sensor (engine) (NTC) or lead defective	Test resistance at temperature sensor:			D27
		engine cold (+15 ... +30° C):		1300 ... 3600 Ω	
		engine at operating temp. (approx. 80°C):		250 ... 390 Ω	
		Check leads from control unit to NTC for:			
		* open-circuit:	3-NTC	Approx. 0 Ω	
			8-NTC	Approx. 0 Ω	
		* short-circuit to ground:	3, 8	Infinity Ω	
2 3 4 1	Lambda closed-loop control outside working range (control limits exceeded or dropped below)	Fault occurs only in idle/part-load range.			E03
		Indication by means of diagnosis lamp if fault has been present for at least 2 minutes.			
		Possible causes of fault:			
		* No or incorrect function of lambda closed-loop control, short-circuit in sensor lead, defective lambda-sensor heating.	— —	— —	
		* Start valve leaking. Test:	— —	— —	
		* Intake system leaking (leakage air). Test:	— —	— —	
		* Tank ventilation valve permanently open. Test:	— —	— —	
		* Incorrect idle adjustment. Test:	— —	— —	

SELF-DIAGNOSIS TEST TABLE (CONTINUED)

Fault indication Flashing code	Testing of component/function	Test instructions/ Test conditions	Termi-nals	Set values	Coord.
2 3 4 2	Lambda sensor or sensor lead defective	Fault is detected and indicated by diagnosis lamp with engine at operating temperature and in range between idle and approx. 3500 min $^{-1}$. * Resistance of lambda sensor: * Test for open-circuit in lead:	 7-grnd. 7	 See brief instruc. Approx. 0 Ω	F03
2 3 4 3	Engine setting too lean (mixture control limit +10 mA exceeded).	Possible causes: * Intake system leaking (leakage air). Test: * Idle adjustment too lean. Setting:	 — — — —	 — — See brief instruc.	F17
2 3 4 4	Engine setting too rich (mixture control limit −5 mA dropped below).	Possible causes: * Start valve leaking. Test: * Idle adjustment too rich. Setting:	 — — — —	 — — See brief instruc.	F25
4 4 3 1	Idle-speed control not functioning	Possible causes: * Voltage supply (ignition term. 15) to idle actuator term. 2 interrupted: * Open-circuit in lead, control unit term. 17 to idle actuator term. 1 or short-circuit to ground. Continuity: Short-circuit to ground: * Idle actuator defective (open-circuit): * Control unit defective, replace.	 2-grnd. 17 2 17 – Grnd. 1 2 — —	 Battery voltage Approx. 0 Ω Infinity Ω See brief instruc. — —	G05
4 4 4 4	No fault detected	——— ———	— —	— —	— —

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (1)

SELF-DIAGNOSIS FLASHING CODE 1111

Control unit defective.

This fault is indicated by the diagnosis lamp lighting up continuously when driving.

No further testing of control unit required.

Control unit O.K.?

N>

Replace control unit.

The control unit is located above the passenger's footwell between bulkhead and vent duct.

Removal: remove lining in front of glove compartment.
Push locking pin towards bulkhead and pull out control unit downwards.

Y

Return to self-diagnosis test table B13

B21 — ⟹

B22 — ⟺

SELF-DIAGNOSIS FLASHING CODE 2113

Magnetic pulse generator defective or open-circuit in lead between control unit and magnetic pulse generator or sensor plate of air-flow sensor sticking in off position.

Note: engine cannot be started if magnetic pulse generator is defective. It may be possible to start the engine if the sensor plate is sticking.

Test power supply:

Switch off ignition and connect control unit connector.

Push back rubber sleeve at connector of ignition distributor.

Switch on ignition and measure voltage at connector, term. 3 (+) and term. 1 (-).

Set value: min. 10 V

Is set value attained?

N>

1. Voltage reading, but too low:

 Detach connector at ignition distributor and repeat measurement.

 Given same result: replace control unit.

 If measurement result O.K.: renew magnetic pulse generator.

2. If reading was 0 V:

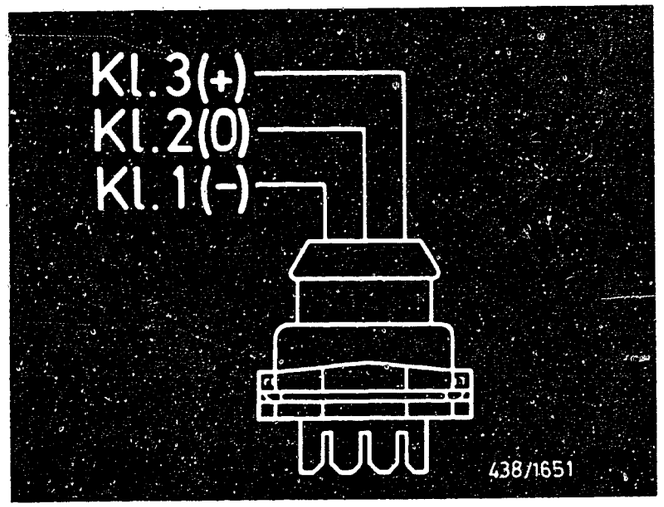
 Switch off ignition and detach both control unit connector and ignition distributor connector.

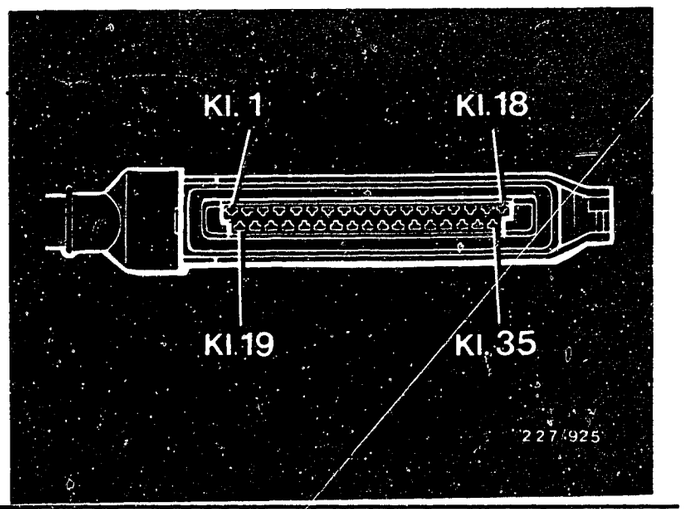
 Test following leads for open-circuit by measuring resistance:
 control unit term. 21 to ignition distributor term. 3 and ignition distributor term. 1 to engine ground (at intake manifold).

 Set value: approx. 0 Ω in each case.

 Eliminate any open-circuit.

 If there was no open-circuit: replace control unit.





Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (2) CONTINUED (1)

Test function of magnetic pulse generator:

All connectors connected.

Detach rubber sleeve at connector of ignition distributor.

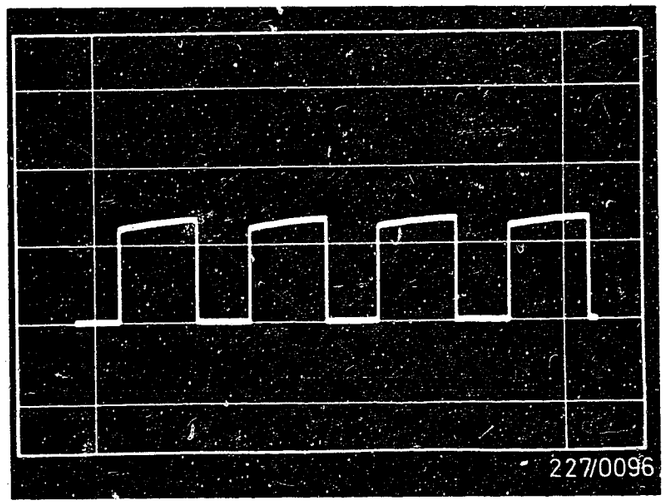
In accordance with operating instructions connect oscilloscope to connector of ignition distributor, term. 2 (center) in program switch setting "special" (signal output).

Example MOT 201:
connect red terminal with test prod to signal output, black terminal to vehicle ground.

Start engine.
Oscilloscope must indicate rectangular pulse (see top picture).

Rectangular pulse present?

N> Renew magnetic pulse generator or ignition distributor.

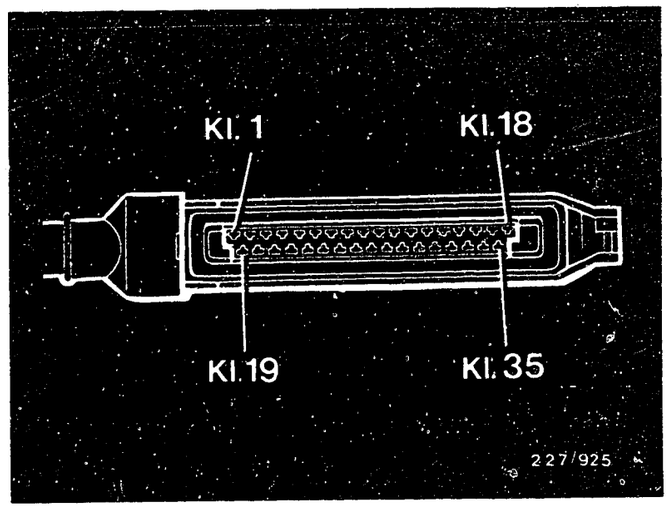


Use ohmmeter to test lead between ignition distributor connector, term. 2 and connector of control unit, term. 30 for continuity.

Set value: approx. 0 Ω

O.K.?

N> Eliminate defect in lead.



Continued on next picture page

Check centering and freedom of movement of sensor plate of air-flow sensor:

Check whether sensor plate is flat (not bent) and whether it can move freely without contact at the narrowest point in the air funnel.

Does sensor plate move freely?

N>

Replace bent sensor plate or re-center sensor plate:

Loosen fastening screw:

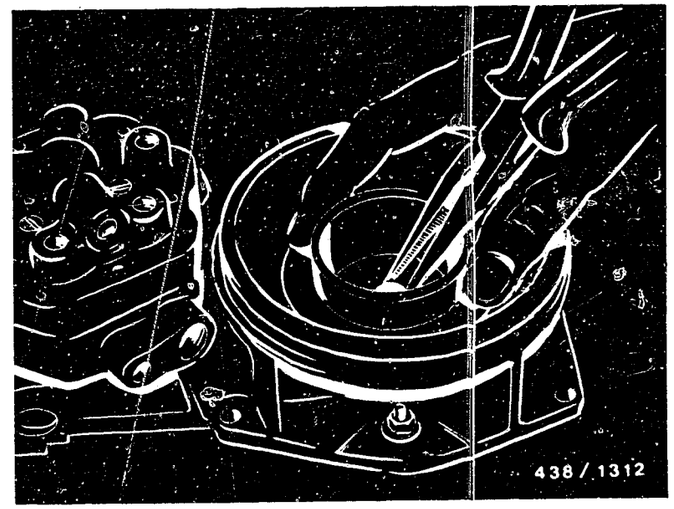
Caution: to lock it, the screw was micro-encapsulated at the factory and is therefore difficult to loosen and turn. If screw is very tight, do not turn by force, but heat with a large soldering iron or with a hot-air fan.

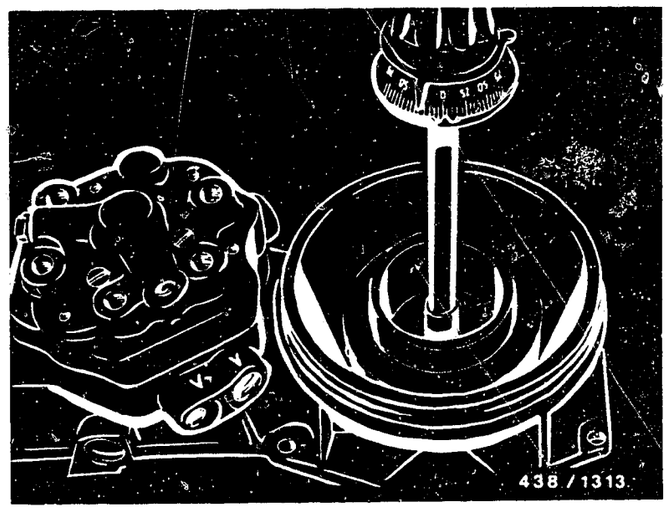
DO NOT USE AN OPEN FLAME!

Center air-flow sensor plate with locating ring KDEP 1040/10 (80 mm) as follows:

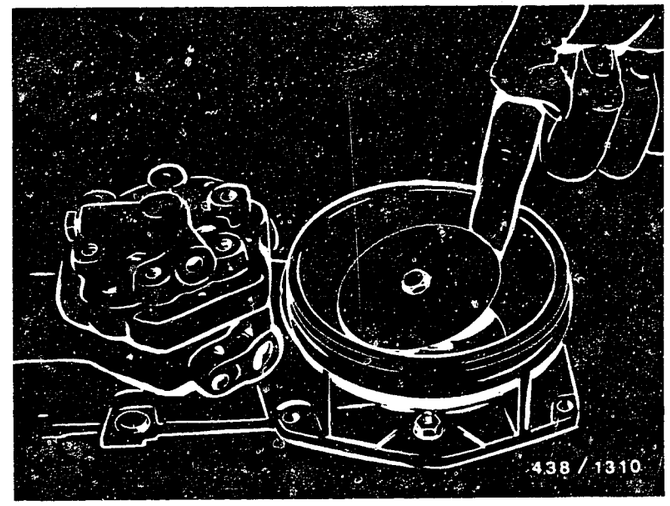
Insert sensor plate with locating ring so that it is in the cylindrical area of the air funnel. Tighten fastening screw to 5...5.5 Nm.

Note: If the screw is very easy to turn (after being loosened several times), clean it and coat it with a little screw-locking compound (e.g. Loctite). Do not use too much in order to enable subsequent loosening. After tightening to the specified tightening torque, it must no longer be possible to turn the sensor plate.





Continued on next picture page



Check control lever in air-flow sensor and control plunger in fuel distributor for freedom of movement:

Important:
* Engine temp. above 20°C.

* Control plunger under pressure (briefly switch on fuel pump by jumping the safety circuit).

1. Control lever:

Raise air-flow sensor plate by hand and release. Plate jumps back into zero position and jumps off the spring-loaded stop about two more times.

N>

If it does not move freely, first loosen all fastening screws of air-flow sensor to establish whether housing torsion is the cause. If this eliminates the stiffness, replace seal between air-filter housing and air-flow sensor (Audi spare part).

When fitting, do not apply any sealing compound between the sealing surfaces.

Tightening torque of air-flow-sensor fastening screws = 9...10 Nm.

If housing torsion is not the cause, replace air-flow sensor.

With the KE-Motronic the air-flow sensor cannot be repaired!

Continued on next picture page

2. Control plunger:

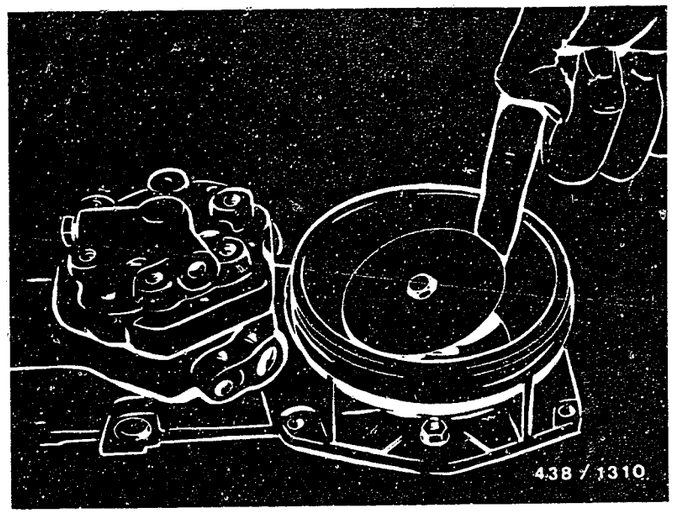
Raise sensor plate by hand. Uniform resistance must be felt over the entire travel. Move sensor plate back quickly to just before the zero position. The plunger slowly follows this movement and must be felt to come to rest on the control lever.

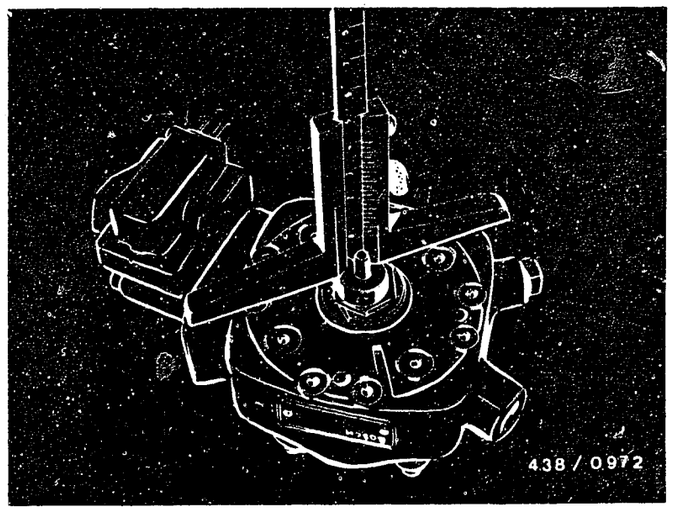
N>

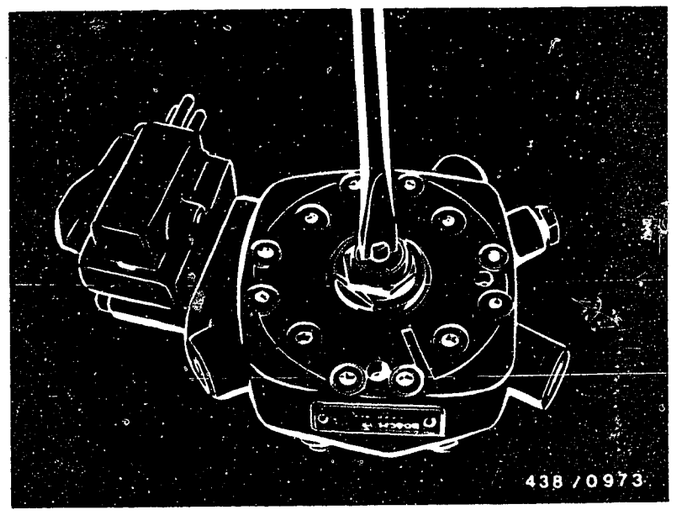
If control plunger stiff, remove fuel distributor from air-flow sensor. To do this, thoroughly clean fuel distributor in area of fuel connections and unscrew all connections. When loosening and subsequently tightening the fuel lines, hold the fixed hexagonal section of the component with a wrench. Unscrew three fastening screws and remove fuel distributor.

Using a depth gauge, measure position of lower slotted round nut of plunger seal in relation to hexagon nut, and note down. In addition, mark rotary position of slotted round nut. Unscrew slotted round nut and remove plunger.

Clean plunger with benzine or similar. If plunger has severe score marks or if freedom of movement cannot be obtained by cleaning, replace fuel distributor. Mechanical cleaning of plunger is not allowable.







Continued on next picture page

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SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (2) CONTINUED (5)

After installing the control plunger in the fuel distributor, screw in slotted round nut of plunger seal as far as the position noted when removing, and turn to the marked position.

Mount fuel distributor with new seal ring on air-flow sensor. Tightening torque for the three fastening screws: 3,2...3,8 Nm

Continued on next picture page

C05 — <==>

C06 — <==>

3. Sensor-plate centering:

Check whether the sensor plate is flat (not bent) and whether it can move freely without contact at the narrowest point in the air funnel.

N>

Replace bent sensor plate or re-center sensor plate:

Loosen fastening screw:

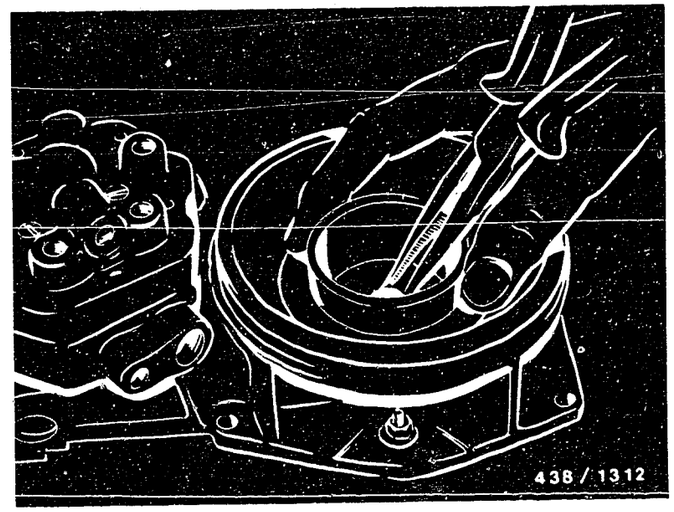
Caution: to lock it, the screw was micro-encapsulated at the factory and is therefore difficult to loosen and turn. If screw is very tight, do not turn by force, but heat with a large soldering iron or with a hot-air fan.

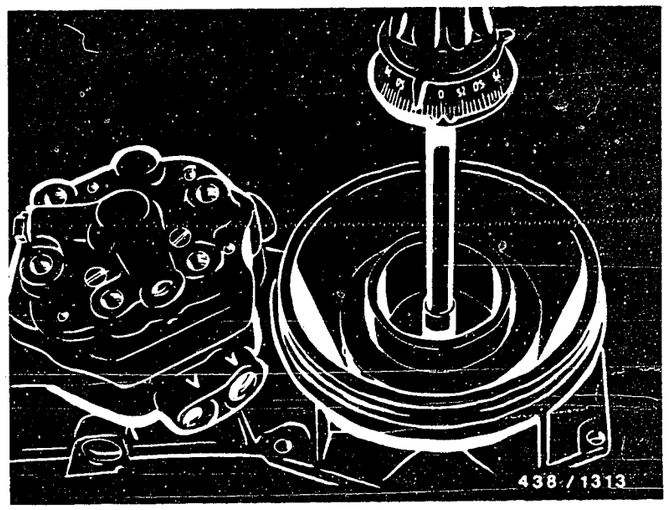
DO NOT USE AN OPEN FLAME!

Center air-flow sensor plate with locating ring KDEP 1040/10 (80 mm) as follows:

Insert sensor plate with locating ring so that it is in the cylindrical area of the air funnel. Tighten fastening screw to 5...5.5 Nm.

Note: If the screw is very easy to turn (after being loosened several times), clean it and coat it with a little screw-locking compound (e.g. Loctite). Do not use too much in order to enable subsequent loosening. After tightening to the specified tightening torque, it must no longer be possible to turn the sensor plate.





Return to self-diagnosis test table B13

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (3)

V

SELF-DIAGNOSIS FLASHING CODE 2121

Throttle-valve switch, idle does not open or short-circuit to ground of signal line or switch incorrectly set.

Test switch function with ohmmeter directly at connector housing (at throttle-valve assembly):

Detach connector housing and connect ohmmeter to connector half on switch end, term. 1 and term. 2.

Set values:
throttle valve
closed: approx. 0 Ω

Throttle valve
open: infinity Ω

O.K.?
(If O.K., leave ohmmeter connected).

N>

Replace throttle-valve switch.

Note: if a defect is found on a throttle-valve switch, both switches (idle and full-load switches) are always to be renewed and reset:

Remove complete throttle-valve assembly. Replace both switches, slightly tighten fastening screws.

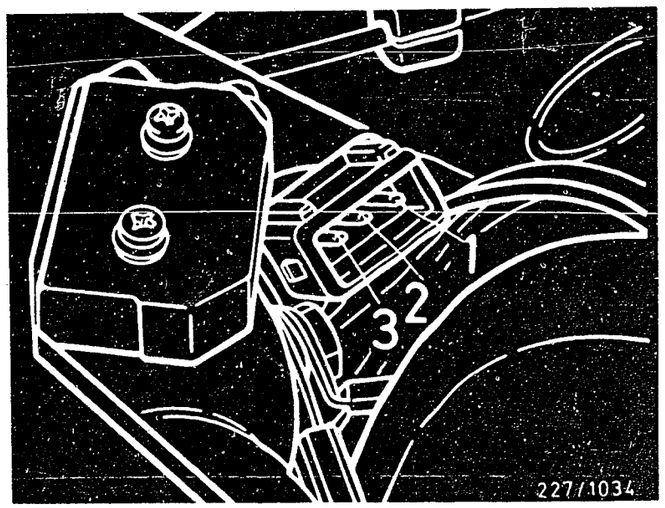
Setting idle switch:

* Connect ohmmeter to idle switch.

* Open throttle valve, close it slowly and determine switching point with ohmmeter.
 Hold throttle valve at switching point and determine distance between throttle-plate lever and idle stop with feeler gauge.

 Set value: 0.15...0.5 mm.
 If necessary, adjust switch by moving it in area of fastening slots.

* After performing adjustment, securely tighten screws and then secure with locking compound.



Y

Continued on next picture page

V

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Adjusting full-load switch:

* Screw graduated disc KDJE 7462 on to throttle shaft (1st stage) and if necessary unscrew fastening nut for throttle-plate lever.

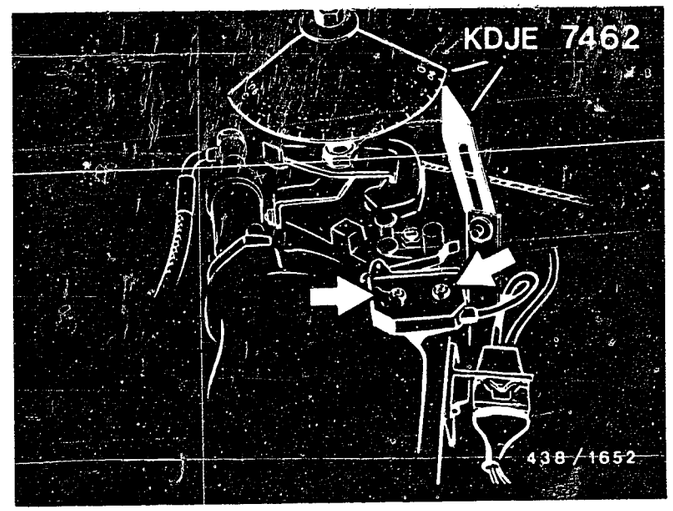
* Set graduated disc to 0°.

* Connect ohmmeter to full-load switch.

* Slowly open throttle valve and determine closing point of switch by measuring resistance.

 Switching-point set value: 8...12° before full-load stop of throttle valve.

* If necessary, loosen fastening screws and adjust switch in area of slots until set value is obtained.
* After performing adjustment, securely tighten fastening screws and then secure with locking compound.



Continued on next picture page

Test idle adjustment of throttle-valve switch:

Open throttle valve, close it slowly and determine switching point with ohmmeter. Hold throttle valve in this position and determine distance between control lever and idle stop with feeler gauge.

Set value: 0.15 ... 0.5 mm.

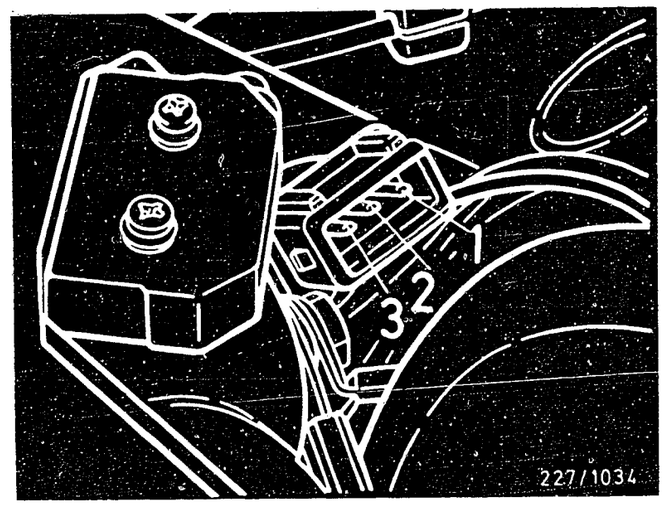
O.K.?

N>

Remove complete throttle-valve assembly and adjust throttle-valve switch, idle:

To do so, loosen fastening screws of switch and turn switch in area of slots such that switching point lies within required value of 0.15...0.5 mm.

Following adjustment, tighten fastening screws and secure with locking compound.



Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (3) CONTINUED (3)

Pull off connector at control unit and disconnect at throttle-valve assembly.

Use ohmmeter to test following leads for continuity/short-circuit to ground:

Control unit, term. 28 to connector of throttle-valve assembly, term. 1; connector of throttle-valve assembly, term. 2 to engine ground (at intake manifold).

Set value: approx. 0 Ω in each case.

Test lead from control unit, term. 28 to ground.

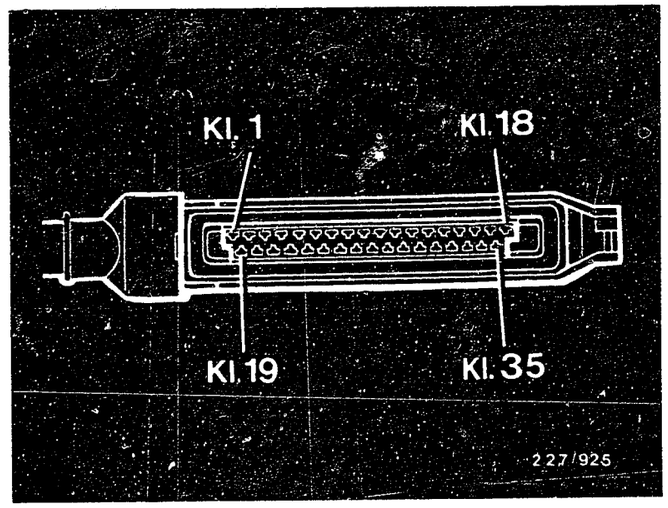
Set value: infinity Ω .

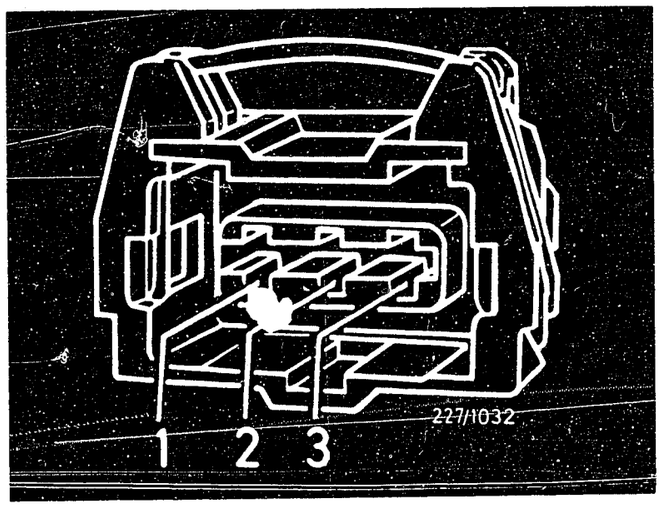
O.K.?

N> Eliminate any open-circuit in lead or short-circuit to ground.

Y

Return to self-diagnosis test table B13





SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (4)

V

SELF-DIAGNOSIS FLASHING CODE 2123

Throttle-valve switch, full load permanently closed or short-circuit to ground of signal line or switch incorrectly set.

Test switch function with ohmmeter directly at connector housing (at throttle-valve assembly):

Detach connector housing and connect ohmmeter to connector half on switch end, term. 2 and term. 3.

Set values:
throttle valve
closed: infinity Ω

Throttle valve fully open: approx. 0 Ω

O.K.?
(If O.K., leave ohmmeter connected.)

N>

Replace throttle-valve switch.

Note: if a defect is found on a throttle-valve switch, both switches (idle and full-load switches) are always to be renewed and reset:

Remove complete throttle-valve assembly. Replace both switches, slightly tighten fastening screws.

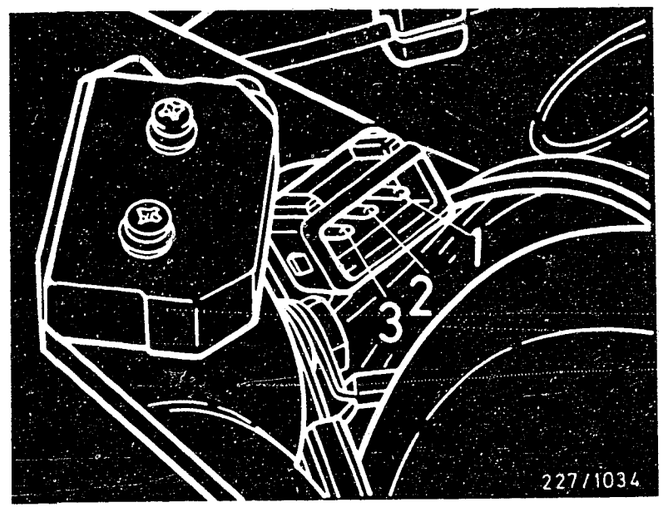
Setting idle switch:

* Connect ohmmeter to idle switch.

* Open throttle valve, close it slowly and determine switching point with ohmmeter.
Hold throttle valve at switching point and determine distance between throttle-plate lever and idle stop with feeler gauge.

Set value: 0.15...0.5 mm.
If necessary, adjust switch by moving it in area of fastening slots.

* After performing adjustment, securely tighten screws and then secure with locking compound.

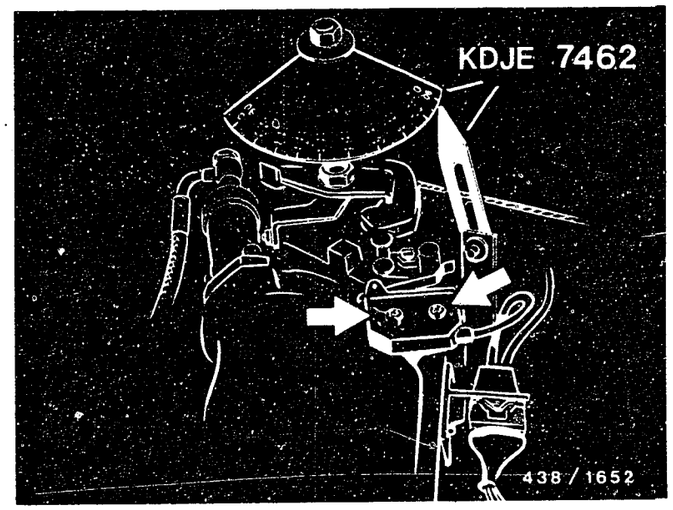


V

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V

Continued on next picture page



Adjusting full-load switch:

* Screw graduated disc KDJE 7462 on to throttle shaft (1st stage) and if necessary unscrew fastening nut for throttle-plate lever.

* Set graduated disc to 0°.

* Connect ohmmeter to full-load switch.

* Slowly open throttle valve and determine closing point of switch by measuring resistance.

 Switching-point set value: 8...12° before full-load stop of throttle valve.

* If necessary, loosen fastening screws and adjust switch in area of slots until set value is obtained.
* After performing adjustment, securely tighten fastening screws and then secure with locking compound.

Continued on next picture page

Test setting of throttle-valve switch, full load:

Screw graduated disc KDJE 7462 on to throttle shaft (1st stage) and if necessary unscrew fastening nut for throttle-plate lever.
Set graduated disc to 0°.

Slowly open throttle valve and determine closing point of switch by measuring resistance.

Switching-point set value:
8 ... 12° before full-load position of throttle valve.

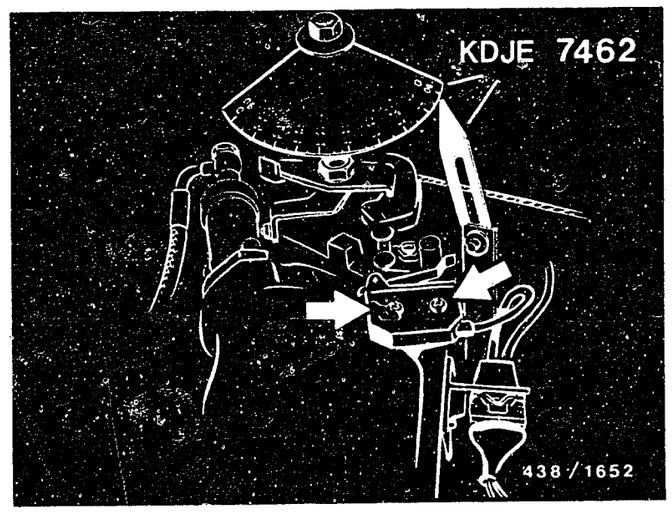
O.K.?

N>

Adjust throttle-valve switch, full load:

To do so, loosen fastening screws and move switch in area of slots such that switching point is within required range 8...12° before full-load stop.

Following adjustment, tighten fastening screws and secure with locking compound.



Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (4) CONTINUED (3)

Pull off control-unit connector and detach at throttle-valve assembly.

Use ohmmeter to test following leads for continuity/short-circuit to ground:

Control unit, term. 31 to connector of throttle-valve assembly, term. 3. Connector of throttle-valve assembly, term. 2 to engine ground (at intake manifold).

Set value: approx. 0 Ω in each case

Test lead from control unit, term. 31 to ground.

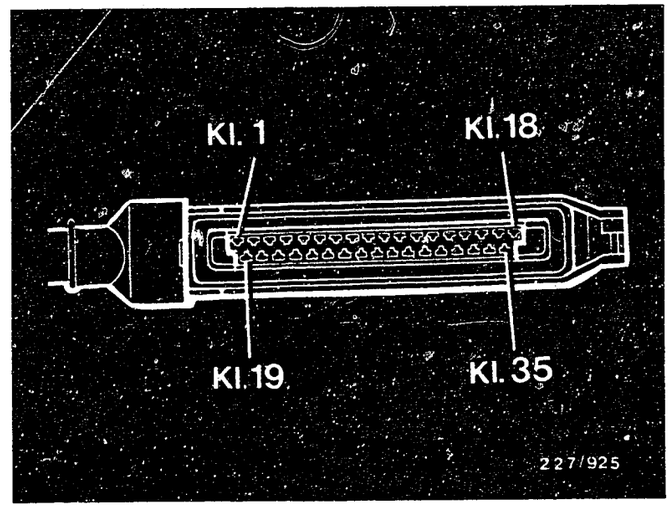
Set value: infinity Ω

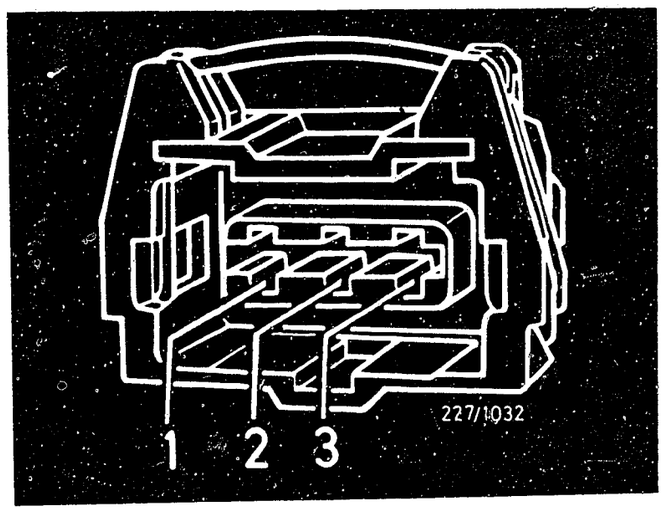
O.K.?

N> Eliminate any open-circuit in lead or short-circuit to ground.

Y

Return to self-diagnosis test table B13





SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (5)

V

SELF-DIAGNOSIS FLASHING CODE 2141

Knock control limit reached.

If engine knocking occurs, the spark-advance angle is retarded by a certain amount and then slowly advanced again.

Diagnosis lamp lights up during the period of maximum retardation.

Possible causes in the system:

* Damage to shielding of knock-sensor lead.

* Incorrect basic ignition setting.

* Incorrect idle adjustment.

Call up self-diagnosis to establish whether other faults have been stored. Eliminate any faults and clear fault memory:

Insert fuse at electric-fuel-pump relay with ignition switched off. Switch on ignition after min. 4 seconds and remove fuse after a further 4 seconds.

V

V

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SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (5) CONTINUED (1)

Check shielding of knock-sensor lead:

* Check lead for damage by subjecting it to visual examination.

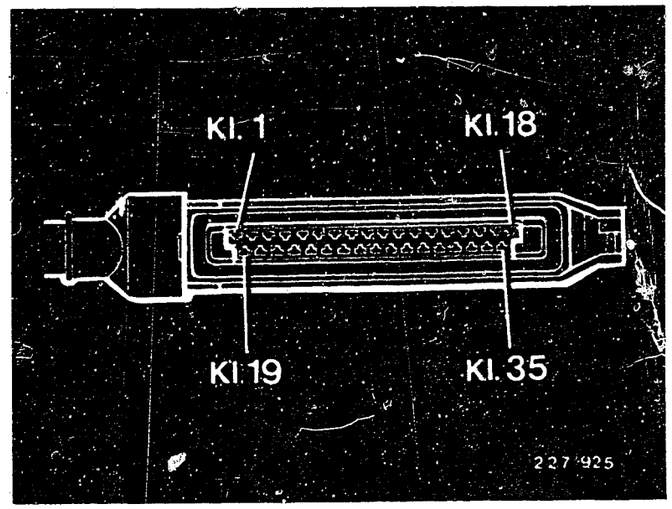
* With ignition switched off, pull off connector at control unit and detach connector at knock sensor.

* Use ohmmeter to test following leads:

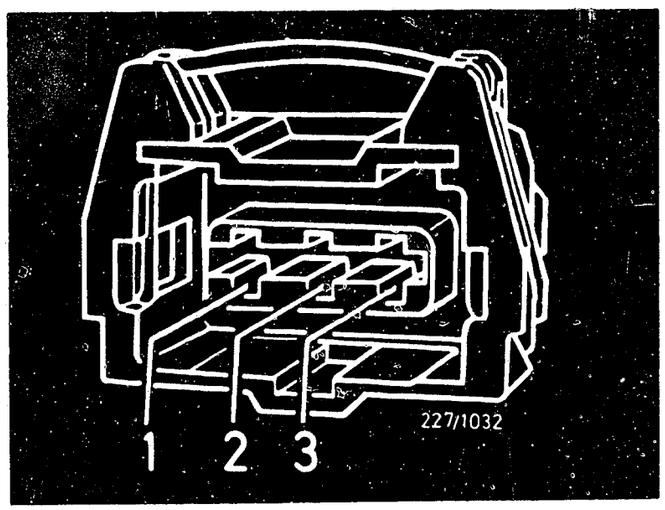
 Control unit, term. 6 to term. 8.
 Set value: infinity Ω

 Control unit, term. 8 to knock-sensor connector, term. 3.
 Set value: approx. 0 Ω

N> Eliminate damage and/or open-circuit and/or short-circuit in knock-sensor lead.



Continued on next picture page



SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (5) CONTINUED (2)

V

Test basic ignition setting:

* Connect motortester in accordance with operating instructions.

* Engine temperature min. 80°C.

* A/C switched off.

* Remove cap from gear housing (for ignition mark).

* Run engine at idle and test firing point (arrow).

 Set values: see vehicle-specific brief instructions.

O.K.?

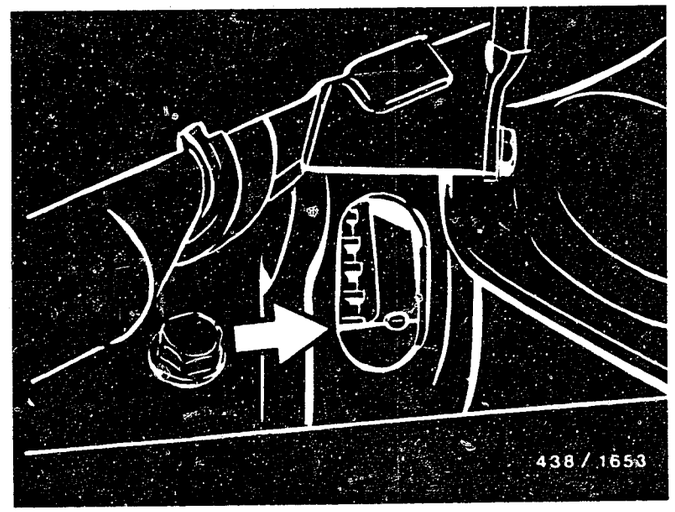
Finally renew cap of gear housing.

(Tachometer remains connected.)

N>

Turn ignition distributor until setting is attained.

Finally renew cap of gear housing.



Y

Continued on next picture page

Test idle adjustment:

Test prerequisites:

* Engine oil temperature min. 80° C.
* Electrical loads switched off (cooling fan must not run during testing/adjustment).
* A/C switched off.
* Pressure gauge KDJE-P 100 not connected.
* Exhaust system must not leak.

Continued on next picture page

V

Test procedure:

Connect ammeter (motortester or multimeter) with test lead KDZS 0004 and KDUM 0008 to KE-pressure actuator of fuel distributor (top picture).

Tightly connect exhaust sampling hose of exhaust-gas analyzer to CO-measuring pipe.

Run engine at idle speed.

Idle-speed set value: see vehicle-specific brief instructions.

Note: speed cannot be adjusted; automatically regulated.

Set value for CO-content: see vehicle-specific brief instructions.

Fluctuating pressure-actuator control current (lambda closed-loop control in operation).

Set value: see vehicle-specific brief instructions.

Are both set values obtained?

N>

Idle adjustment:

* Pull cap off activated-carbon canister.

* Detach crankcase breather hose at cylinder head cover and seal it tight.

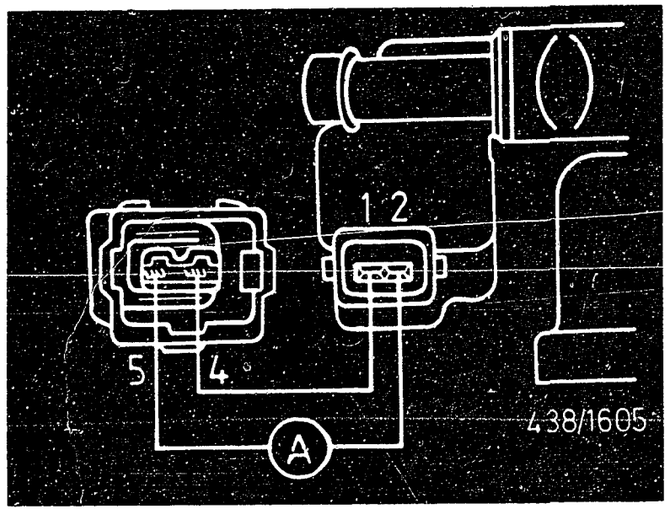
* Detach crankcase breather hose at breather housing (on engine block).

* Remove CO anti-tamper safeguard (plug) at KE-air flow sensor with special tool kit (e.g. Hazet tool kit 4521/7).

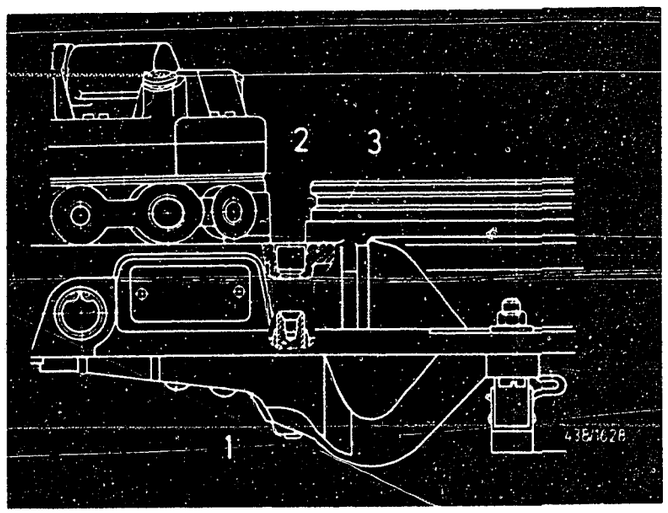
Start engine and run at idle. Adjust pressure-actuator control current if necessary by adjusting the idle-mixture-adjusting screw in the mixture-control unit (bottom picture).

Anti-clockwise direction: increased current
Clockwise direction: reduced current

Note: the CO value is a reference value and results automatically given closed-loop control and a correctly set current value. There is no possibility of adjustment.



1 = Idle-mixture-adjusting screw
2 = Plug
3 = KE-air-flow sensor



Y

Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (5) CONTINUED (5)

Further possible causes of flashing code 2141 (knock control limit reached):

* Fuel with too low an octane number.

* Engine damage

N>

Use a different type of fuel on trial basis; be sure to use high-grade fuel.

Have engine checked and if necessary repaired.

Return to self-diagnosis test table B15

D07 — <⟹>

D08 — <⟹>

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (6)

SELF-DIAGNOSIS FLASHING CODE 2142

Knock sensor defective, open-circuit in lead or contact resistance.

Fault recognition as of engine speed approx. 2650 min $^{-1}$. Diagnosis lamp lights up continuously until engine is switched off.

With ignition switched off, detach control-unit connector; unplug connector at knock sensor.

Use ohmmeter to check following leads for open-circuit or short-circuit:

Control unit	–	Knock sensor
term. 6		term. 1
term. 8		term. 2
term. 8		term. 3

Set value: approx. 0 Ω in each case

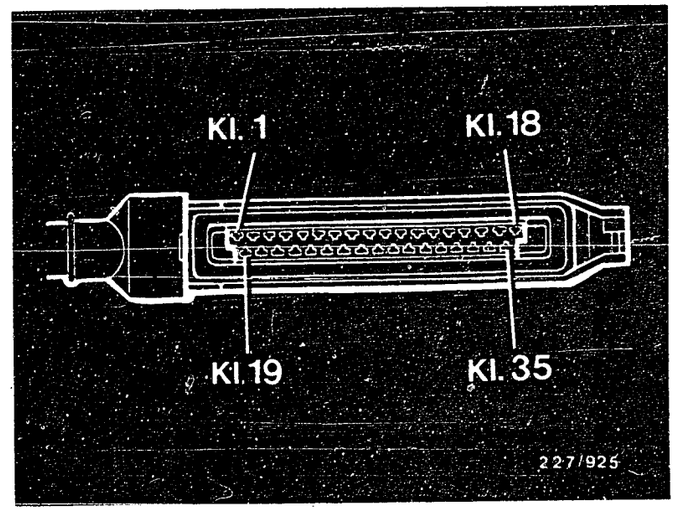
term. 6		term. 2

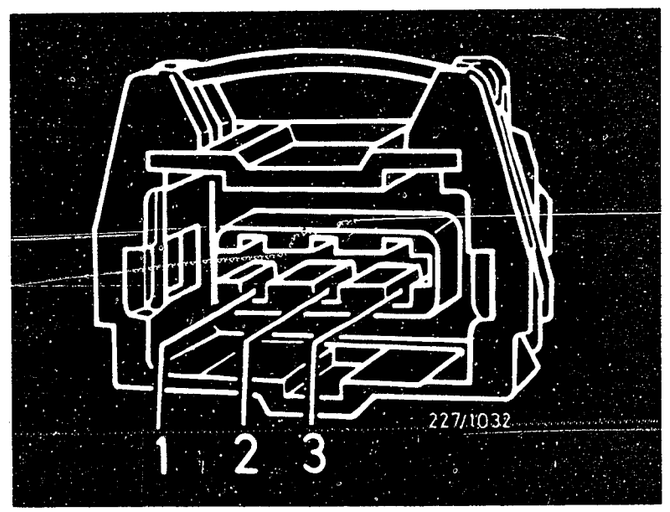
Set value: infinity Ω

O.K.?

N> Eliminate any open-circuit in lead or short-circuit.

Continued on next picture page





SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (6) CONTINUED (1)

Renew knock sensor on a trial basis.

Adhere precisely to tightening torque for fastening screw of new knock sensor. Refer to brief instructions for value.

Start engine and run for at least 1 minute at a speed in excess of 2650 min^{-1} . Check whether fault has now been eliminated by activating self-diagnosis.

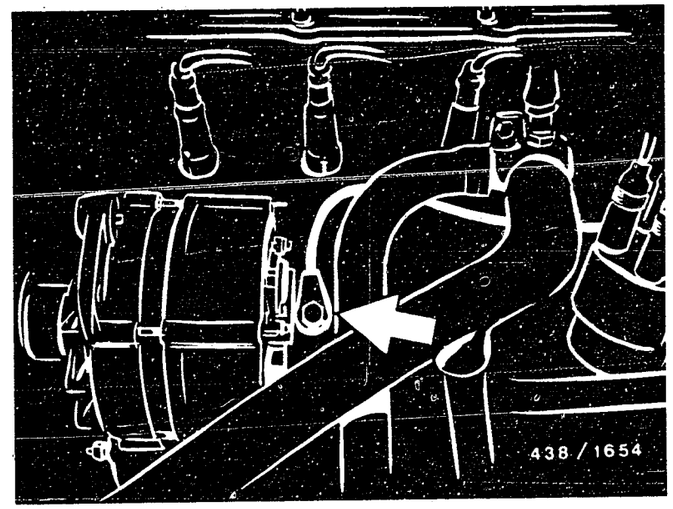
Fault now eliminated?

N>

If replacing the knock sensor on a trial basis does not eliminate the fault, install old knock sensor again.

The fault is then to be found in faulty control-unit knock detection.

Replace control unit.



Y

Return to self-diagnosis test table B15

D11 — <==>

D12 — <==>

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (7)

V

SELF-DIAGNOSIS FLASHING CODE 2231

Idle speed control not within working range.

Possible causes:

* Basic setting of throttle valve not O.K.

* Intake system leaking (leakage air).

* Basic ignition setting incorrect.

Y

V

Continued on next picture page

D13 — <⟹>

D14 — <⟹>

Basic setting of throttle valve:

The adjusting screw (arrow) for the basic setting of the throttle valves is set precisely at the factory and sealed with locking compound. This setting should normally not be changed.

A visual inspection is to be performed to establish whether the locking compound has been removed, whether previous manipulation on the throttle-valve assembly is to be suspected on the basis of traces of work having been performed or whether readjustment has become necessary as a result of wear.

O.K.?

N>

In the event of uncertainty the basic setting of the throttle valve can be readjusted:

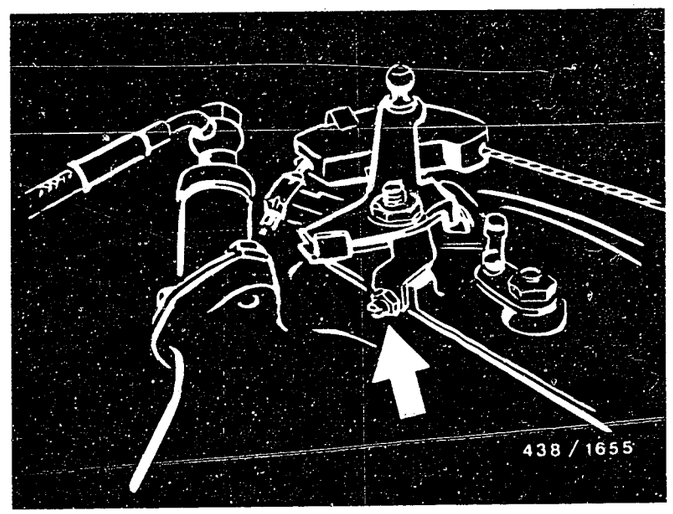
* Turn back adjusting screw (arrow) until there is a gap between the screw and the stop.

* Screw in adjusting screw until it just contacts the stop.

 Note: to facilitate work, hold a thin piece of paper between adjusting screw and stop. Determine contact point by constantly moving the paper and at the same time screwing in the screw.

* As of point of contact, screw in the adjusting screw precisely half a turn further and lock.

 Secure adjusting screw with locking compound.



Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (7) CONTINUED (2)

V

Check air-intake system of engine for leaks:

The arrows in the picture indicate the typical points at which leaks may occur. Check by visual examination or, if unsure, as follows:

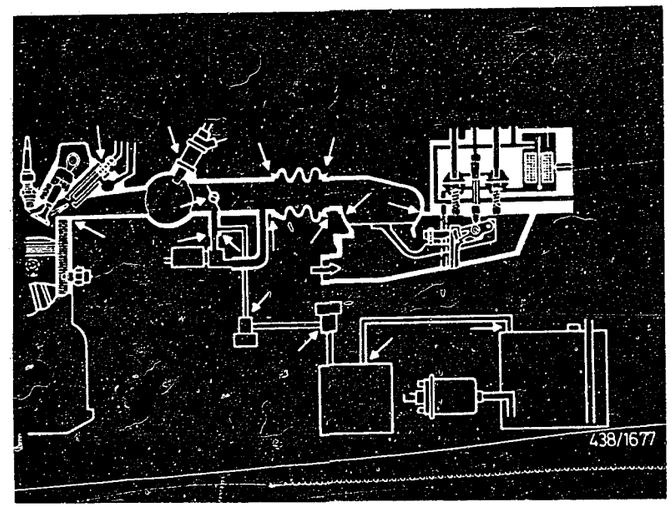
Disconnent hose from outlet of idle actuator and, using a compressed-air gun, blow air into the air-routing system through this hose. Open throttle-valve fully when doing this. Brush or spray joints with soapy water or with leak-detector spray (e.g. GÜpoflex).

Under no circumstances may combustible liquids be used for testing for leaks.

Bubbling or foaming indicates a leak.

Air-intake system leak-tight?

N> Eliminate leaks in air-intake system.



Y

Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (7) CONTINUED (3)

Test basic ignition setting:

* Connect motortester in accordance with operating instructions.

* Engine temperature min. 80°C.

* A/C switched off.

* Remove cap from gear housing (for ignition mark).

* Run engine at idle and test firing point (arrow).

 Set values: see vehicle-specific brief instructions.

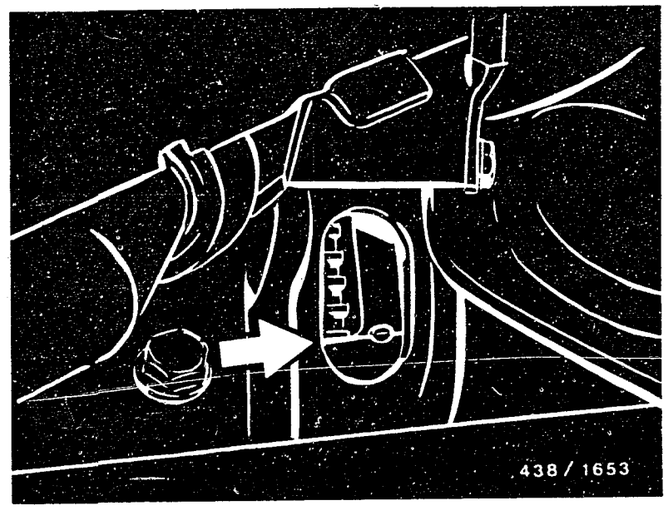
O.K.?

Finally renew cap of gear housing.

(Tachometer remains connected.)

N> Turn ignition distributor until setting is attained.

Finally renew cap of gear housing.



Return to self-diagnosis test table B15

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (8)

SELF-DIAGNOSIS FLASHING CODE 2232

Potentiometer at air-flow sensor defective or short-circuit or open-circuit in lead.

With ignition switched off, attach control-unit connector and detach connector at potentiometer plug.

Switch on ignition and measure potentiometer power supply at connector term. 1 (+) and term. 3 (-).

Set value: 4.35 ... 5.35 V

Is set value attained?

N>

Switch off ignition and detach control-unit connector.

Use ohmmeter to check following leads for open-circuit:

Control unit	Potentiometer
term. 26	term. 1
term. 35	term. 3

Set value: approx. 0 Ω in each case

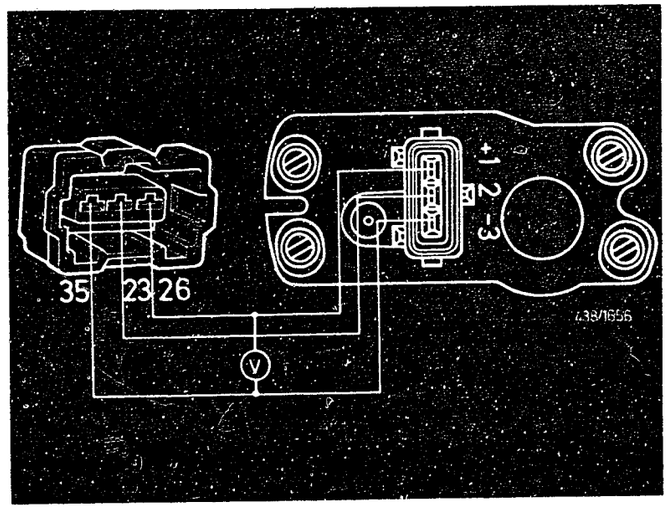
Test for short-circuit:

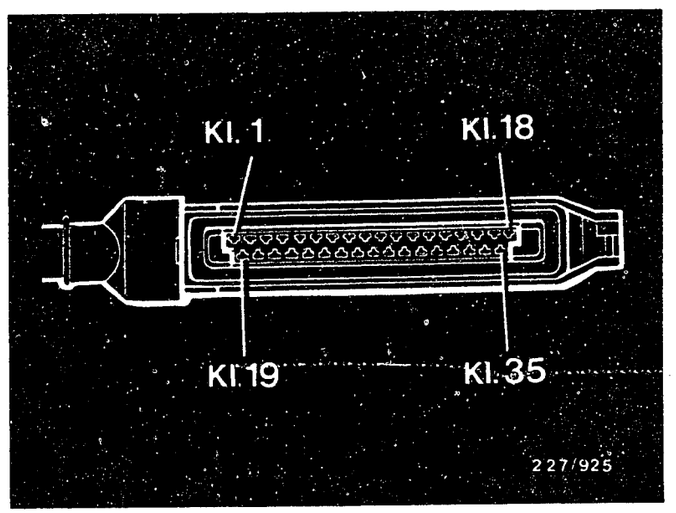
term. 26	term. 3
term. 26	ground

Set value: infinity Ω in each case

If no fault in lead: control unit defective.

Replace control unit.





Continued on next picture page

Test voltage signal of potentiometer with voltmeter:

Re-establish connection between detached connector and potentiometer, terminals 1 and 3 with test leads KDZS 0004 and KDUM 0008.

Switch on ignition and measure voltage at potentiometer, term. 2 (+) and 3 (-).

Set values:
sensor-plate off position: 0...0.1 V

Slowly lift sensor plate:
voltage increase up to max. 5.35 V

Voltage signal present?

Note: testing of potentiometer setting or re-adjustment is performed with engine idling, possibly in conjunction with idle adjustment.

N>

Renew air-flow sensor.

The following is to be observed when effecting removal and installation:

* Counterhold fixed hexagon when detaching or subsequently connecting fuel lines at fuel distributor.

* Do not use any sealing compound between air-flow sensor and air-filter housing.

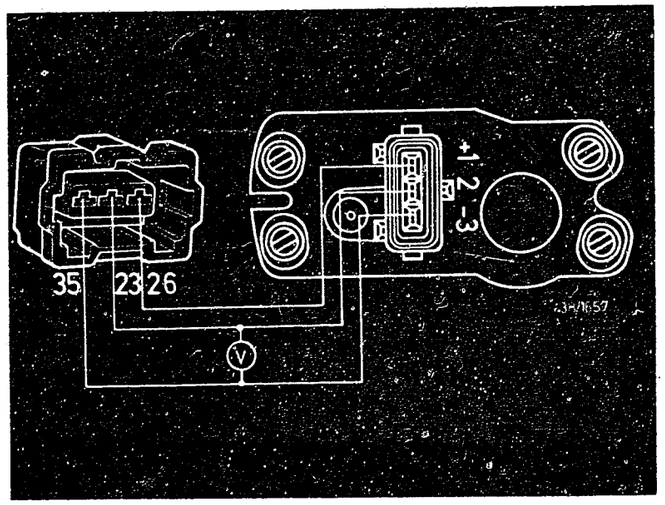
* Tightening torques of fastening screws:
 9 ... 10 Nm

* Renew sealing ring between fuel distributor and air-flow sensor.

* Tightening torque of fuel-distributor fastening screws: 3.2...3.8 Nm

* Finally carry out idle adjustment (coordinate L23) and check idle motion of sensor plate.

 Set value for idle motion:
 "perceptible" up to 2 mm in center of sensor plate.



Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (8) CONTINUED (2)

V

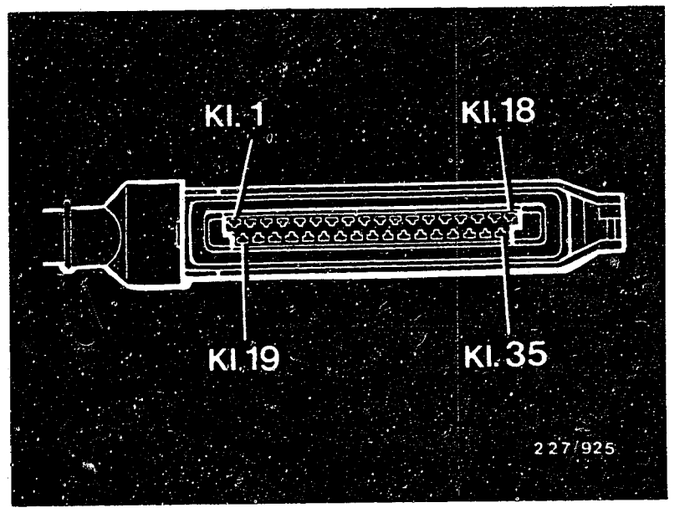
Use ohmmeter to test lead from control unit, term. 23 to potentiometer, term. 2:

Continuity.
Set value: approx. 0 Ω

Short-circuit to ground.
Set value: infinity Ω

Short-circuit with lead, term. 1 of potentiometer.
Set value: infinity Ω

N> Eliminate defect in lead.



V

Return to self-diagnosis test table B17

D25 — <==>

D26 — <==>

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (9)

V

SELF-DIAGNOSIS FLASHING CODE 2312

Temperature sensor (engine) defective or open-circuit in lead, contact resistance, short-circuit to ground.

Test temperature sensor:

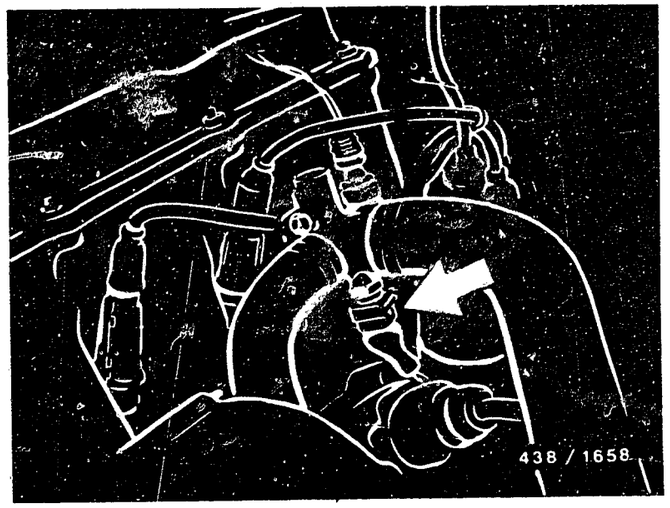
Detach connector and connect ohmmeter to both connections of temperature sensor.
Set values:

Cold engine:
(15...30°C) 1300...3600 Ω

Engine at operating temperature:
(approx. 80°C) 250...390 Ω

N>

Renew defective temperature sensor.



Y

V

Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (9) CONTINUED (1)

Detach control-unit connector with ignition switched off.

Use ohmmeter to test lead from control unit, term. 3 to connector of temperature sensor:

Continuity.
Set value: approx. 0 Ω

Short-circuit to ground.
Set value: infinity Ω

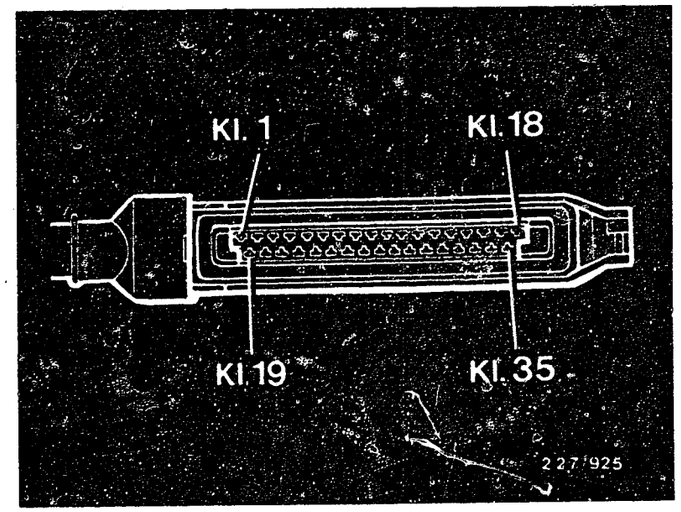
N> Eliminate defect in lead.

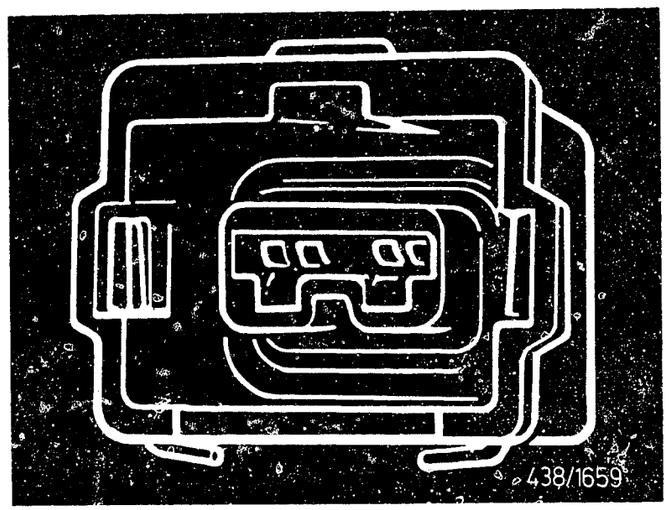
Use ohmmeter to perform continuity test on lead from grounding point, intake manifold to temperature sensor connector.

Set value: approx. 0 Ω

N> Eliminate any open-circuit in lead or contact resistance.

Return to self-diagnosis test table B17





SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (10)

SELF-DIAGNOSIS FLASHING CODE 2341

Lambda closed-loop control outside working range (control limits exceeded or dropped below)

Note: fault only occurs in idle or part-load range.

Diagnosis lamp lights up if fault has been present for at least 2 minutes.

Possible causes of fault:

* No or incorrect functioning of lambda closed-loop control, short-circuit in lambda sensor lead to + or ground, lambda sensor heating defective.
* Start valve leaking.
* Engine intake system leaking.
* Tank ventilation valve(s) permanently open.
* Incorrect idle adjustment.

Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (10) CONTINUED (1)

Test lambda closed-loop control function of control unit:

N>

Pull off connector at KE-pressure actuator and connect to actuator again via test leads KDZS 0004 and KDUM 0008 such that ammeter (motortester or multimeter) can be connected (top picture).

Disconnect battery negative and connect again after 1 minute (operation is designed to clear memory).

Detach connector of lambda sensor (center picture, arrow).

Start engine and allow it to idle.

Measure pressure-actuator control current (open-loop control).

Set value:
constant reading -1...+1 mA.

O.K.?

Continued on next picture page

Possible causes if current reading too high:

* Short-circuit to ground in sensor lead.

 Switch off engine and pull off control-unit connector. Use ohmmeter to measure resistance between term. 7 and term. 8 of connector.

 Set value: infinity Ω

 Eliminate any short-circuit to ground.

* If no short-circuit to ground present: control unit defective, replace control unit.

Possible causes if current reading too low:

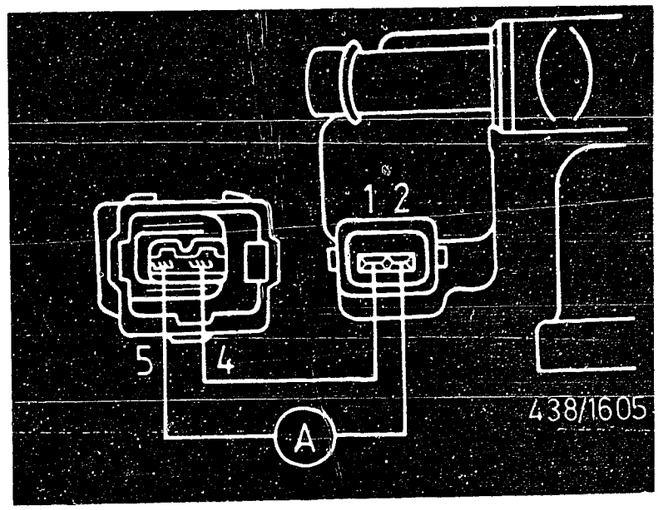
* Short-circuit in sensor lead to U_{bat}.

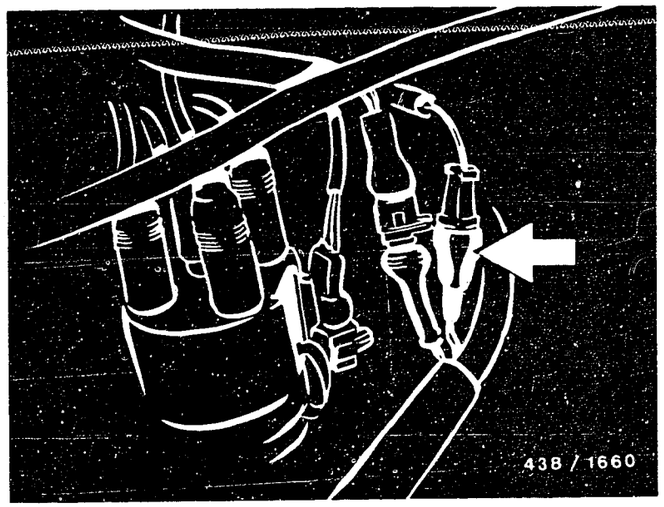
 Switch off engine and pull off control-unit connector. Use ohmmeter to measure resistance between term. 7 and term. 14 of connector.

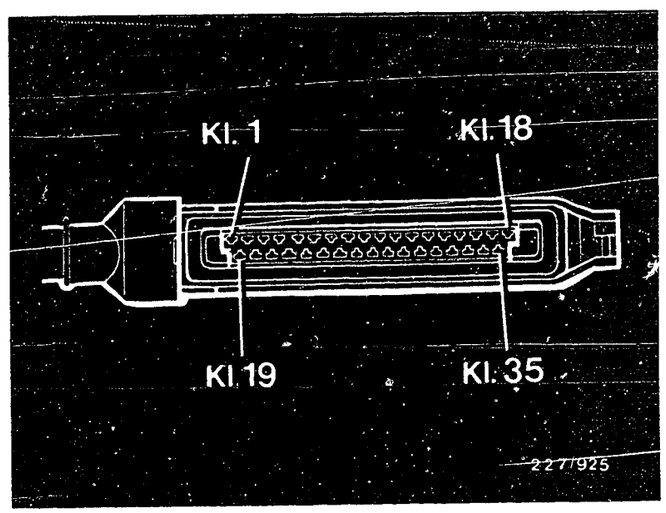
 Set value: infinity Ω

 Eliminate any short-circuit in sensor lead to live lead.

 If no fault present: control unit defective.







SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (10) CONTINUED (2)

Test control function of control unit:

Run engine at idle.

* Hold lambda sensor lead to control unit against vehicle ground. Current reading must increase.

 Set value: see vehicle-specific brief instructions.

* Hold lambda sensor lead to control unit against positive pole of a 1.5 V unicell and hold negative pole of unicell against vehicle ground. Current reading must decrease.

 Set value: see vehicle-specific brief instructions.

Are both set values attained?

N>

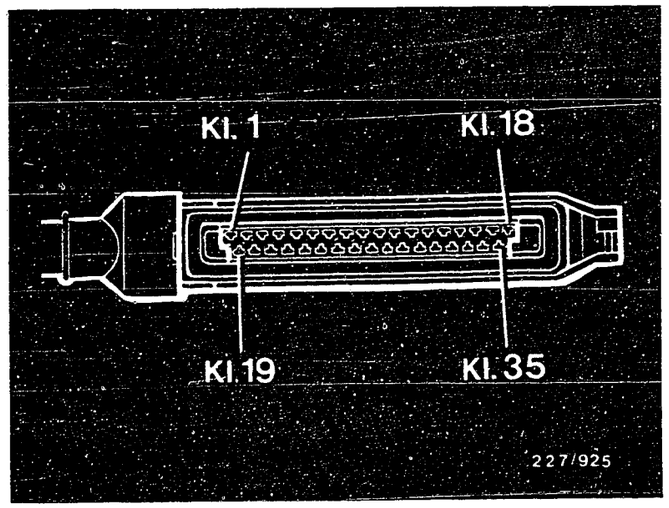
Switch off engine and pull off control-unit connector.

Use ohmmeter to perform continuity test on lead from term. 7 of control-unit connector to plug connection of sensor lead.

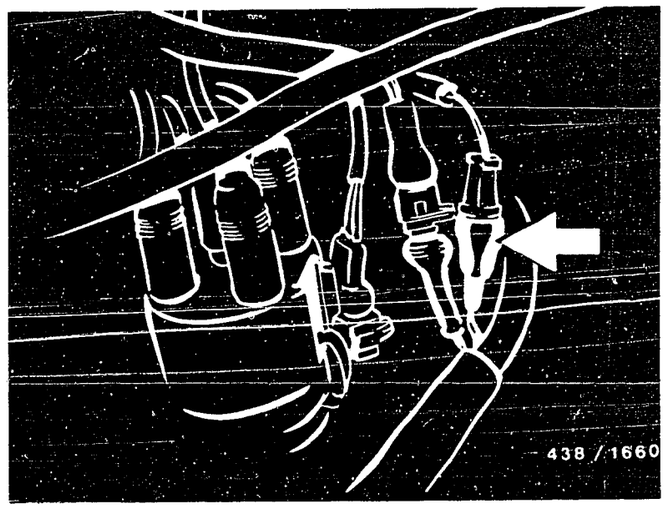
Set value: approx. 0 Ω

Eliminate any open-circuit.

If no open-circuit present: control unit defective, replace control unit.



Continued on next picture page



SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (10) CONTINUED (3)

Test lambda sensor:

Connect plug connection of lambda sensor (arrow).

Start engine, run it up to operating temperature (approx. 80°C) and allow it to run at idle. Take current reading.

Set value: reading fluctuating around 0 mA

O.K.?

N>

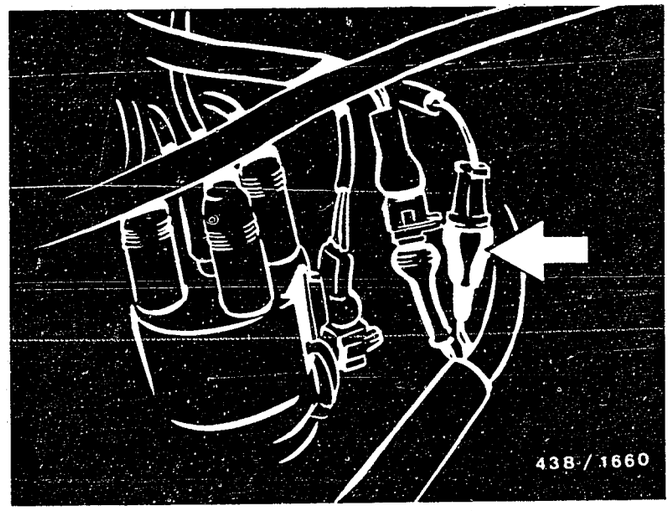
* Reading fluctuates, however mean value not about 0 mA:

 Correct CO-adjustment within scope of idle adjustment (at the end of this section).

* Current static (does not fluctuate): lambda sensor defective, replace sensor.

 Note: prior to installation, apply fitting paste VS 14016 Ft to thread of lambda sensor. Ensure that no paste gets into slots in protective conduit.

 Part number of paste: 5 964 080 112.



Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (10) CONTINUED (4)

Test lambda sensor heating:

Switch off engine.
Disconnect (arrow) 2-pole plug connection for sensor heating (next to plug connection for sensor lead).

Switch on ignition and measure voltage between both contacts at connector of sensor heating.

Set value: battery voltage.

Is set value attained?

N>

* Use ohmmeter to check lead from connector of sensor heating to fuse 24.

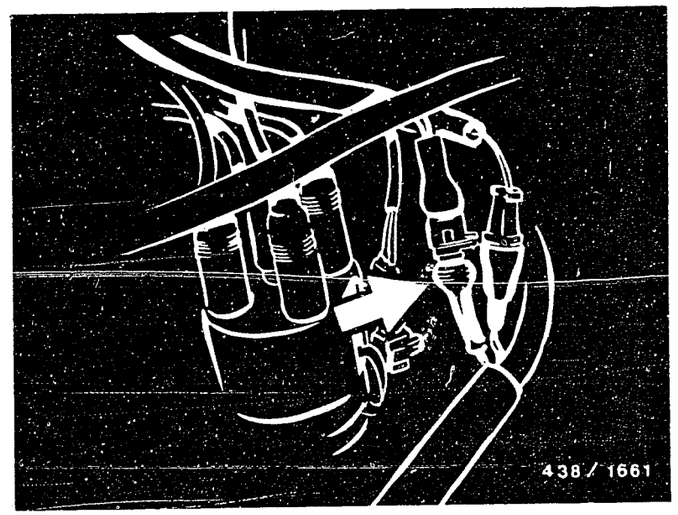
 Set value: approx. 0 Ω

 Eliminate any open-circuit.

* If O.K., perform continuity test on lead from connector of sensor heating to vehicle ground.

 Set value: approx. 0 Ω

 Eliminate open-circuit.



Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (10) CONTINUED (5)

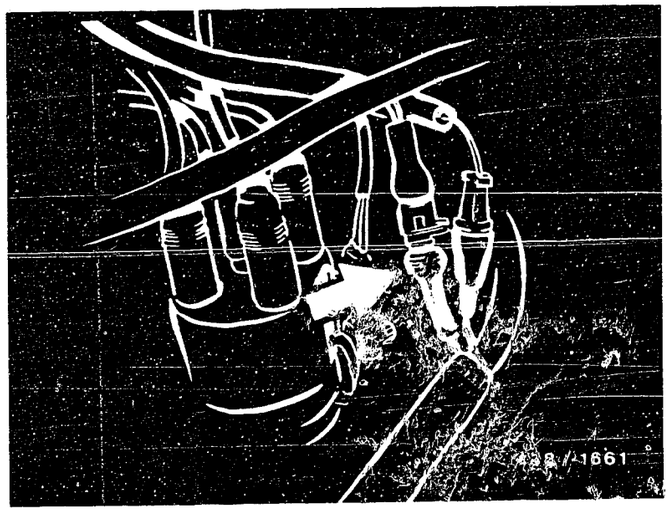
Use ohmmeter to measure internal resistance of lambda sensor heating at sensor half of connector (top picture, arrow).

Set value: 1...15 Ω

O.K.?

N> Replace lambda sensor.

Note: prior to fitting, apply fitting paste VS 14016 Ft to thread of lambda sensor. Ensure that no paste gets into slots in protective conduit.



Test start valve for leaks:

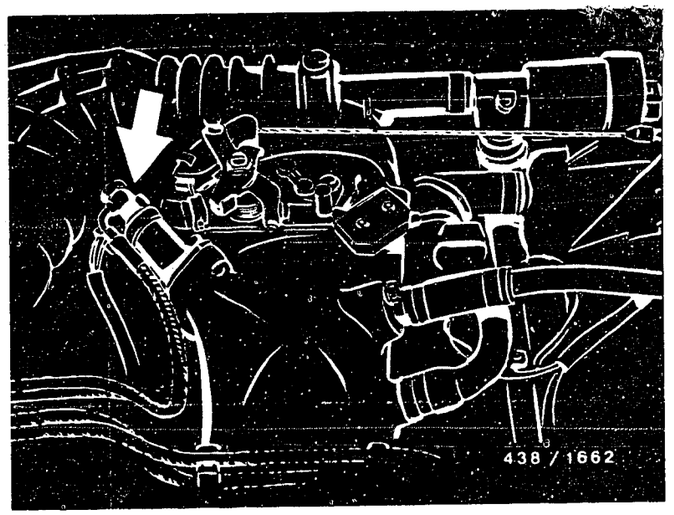
Remove start valve.
The fuel line remains connected.
Do not bend or damage line.

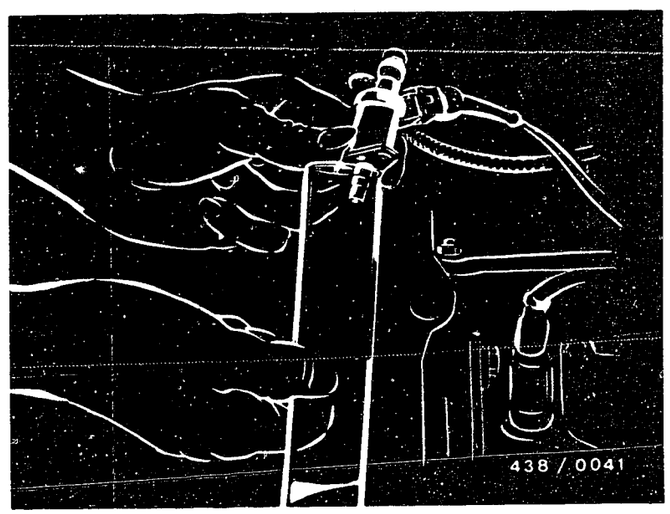
Switch on electric fuel pump by bridging the safety circuit. To do so, detach relay in central-electrics console, relay position 10, and jump contacts 48 and 52 with auxiliary lead.

Clean nozzle of start valve. No droplet may drip off at the nozzle within one minute. The start valve must be leak-proof even when shaken and knocked.

N> Replace leaking start valve.

Note: if the start valve had to be replaced on account of a leak, the idle adjustment must be checked and corrected if necessary (following coordinate).





Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (10) CONTINUED (6)

V

Check air-intake system of engine for leaks:

The arrows in the picture indicate the typical points at which leaks may occur. Check by visual examination or, if unsure, as follows:

Disconnent hose from outlet of idle actuator and, using a compressed-air gun, blow air into the air-routing system through this hose. Open throttle-valve fully when doing this. Brush or spray joints with soapy water or with leak-detector spray (e.g. GÜpoflex).

Under no circumstances may combustible liquids be used for testing for leaks.

Bubbling or foaming indicates a leak.

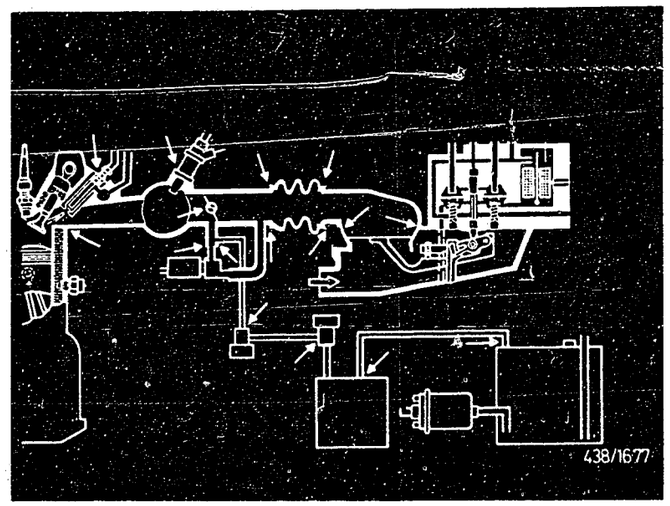
Air-intake system leak-tight?

N> Eliminate leaks in air-intake system.

Y

V

Continued on next picture page



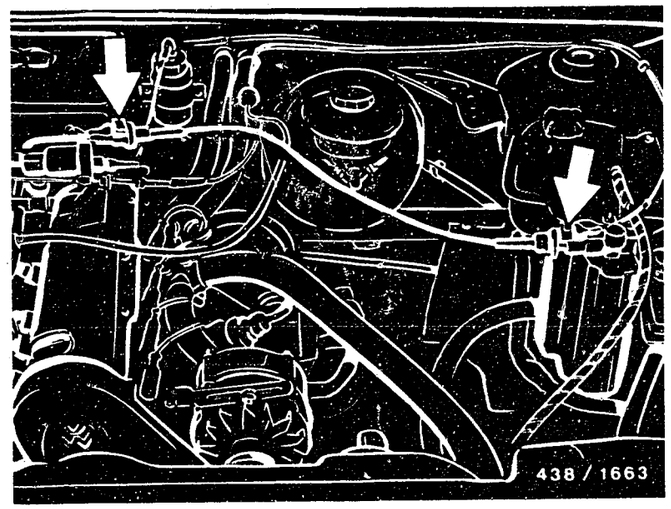
SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (10) CONTINUED (7)

Check tank-ventilation system.

Check visually whether hoses of tank-ventilation system are correctly attached, not bent or damaged.
Check whether hose connections at intake manifold, tank bleeder valve, active-carbon canister and fuel tank are leak-tight.

Are all hoses and connections O.K.?

N> Replace defective hoses as necessary.
Eliminate leakages by tightening hose clamps.



Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (10) CONTINUED (8)

Check function of tank ventilation valve (ACF frequency valve, with active-carbon canister):

Test actuation signal for ACF frequency valve with oscilloscope. To do so, connect two-pin test lead 1 684 463 093 between frequency valve and its connector.

Connect motortester (special input) to test lead:
red pickup to one of the test-lead connections, black pickup to engine ground.

Note: the free terminal of the test lead must not come into contact with ground.

Start warm engine and let it idle.

If correctly connected the oscilloscope shows pulses corresponding to the adjacent picture (top).

Set value: pulses

Pulses present?

N>

Switch off engine and remove both control-unit connector and frequency valve.

* Use ohmmeter to perform continuity test on lead from control unit, terminal 15 to connector of frequency valve, terminal 2.

 Set value: 0 Ω

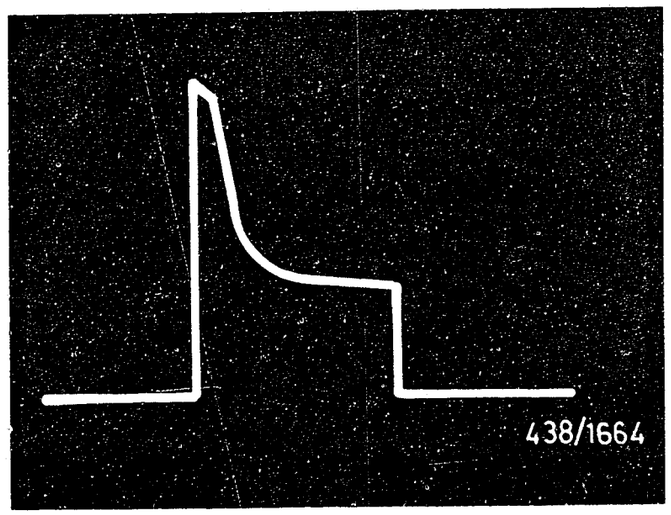
 Eliminate any open-circuit.

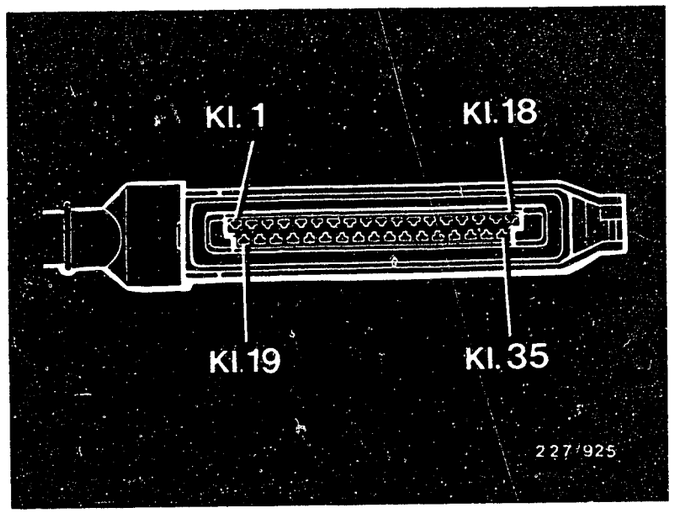
* Switch on ignition and use voltmeter to test power supply at connector of frequency valve, terminal 1.

 Set value: battery voltage.

 Eliminate any interruption in power supply from ignition lock via fuse 24 to frequency valve.

If no fault in lead:
control unit defective, renew control unit.





Continued on next picture page

Switch off engine and detach connector at ACF frequency valve.

Use ohmmeter to measure internal resistance of valve directly at both contacts.

Set value: see vehicle-specific brief instructions.

O.K.?

N> Internal resistance outside tolerance: ACF frequency valve defective. Replace valve.

Y

Test mechanical switching function of ACF frequency valve:

Connect term. 1 of connector with test leads KDZS 0004 and KDUM 0008 to corresponding contact of valve. Connect further test lead KDZS 0004 to second valve contact.

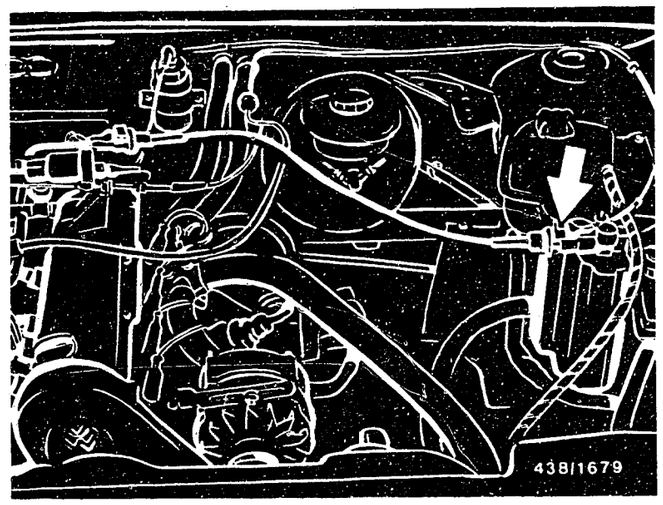
Switch on ignition and briefly hold test lead against engine ground several times.
The valve must switch both audibly and perceptibly.

O.K.?

N> Replace sticking or difficult-to-move ACF frequency valve.

Y

Continued on next picture page



Check function of switching valve for tank ventilation (on intake manifold):

Note: the switching valve is closed when the engine is off and open when it is running.

Pull off connector at switching valve.

Perform voltage measurement at both contacts of connector.

Set values:

* ignition on: battery voltage

* ignition off: 0 V

O.K.?

N>

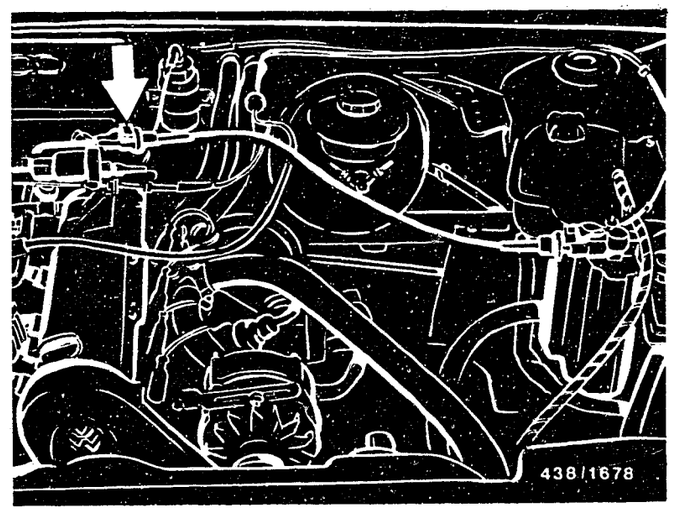
No voltage reading with ignition switched on:

Check fuse 24 for engine timing.

Use ohmmeter to perform continuity test on leads from connector to ignition switch, terminal 15 and from connector to ground point (intake manifold).

Set values: approx. 0 Ω in each case

Eliminate open-circuit.



Y

Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (10) CONTINUED (11)

Perform resistance measurement directly at the two plug pins of the switching valve.

Set value: see vehicle-specific brief instructions.

O.K.?

N> Replace defective switching valve.

Y

Remove switching valve and blow compressed air through it.

Set value: the valve must be completely leakproof.

O.K.?

N> Replace leaking switching valve.

Y

Continued on next picture page

Test idle adjustment:

Test prerequisites:

* Engine oil temperature min. 80° C.

* Electrical loads switched off (cooling fan must not run during testing/adjustment).

* A/C switched off.

* Pressure gauge KDJE-P 100 not connected.

* Exhaust system must not leak.

Continued on next picture page

Test procedure:

Connect ammeter (motortester or multimeter) with test lead KDZS 0004 and KDUM 0008 to KE-pressure actuator of fuel distributor (top picture).

Tightly connect exhaust sampling hose of exhaust-gas analyzer to CO-measuring pipe.

Run engine at idle speed.

Idle-speed set value: see vehicle-specific brief instructions.

Note: speed cannot be adjusted; automatically regulated.

Set value for CO-content: see vehicle-specific brief instructions.

Fluctuating pressure-actuator control current (lambda closed-loop control in operation).

Set value: see vehicle-specific brief instructions.

Are both set values obtained?

N>

Idle adjustment:

* Pull cap off activated-carbon canister.

* Detach crankcase breather hose at cylinder head cover and seal it tight.

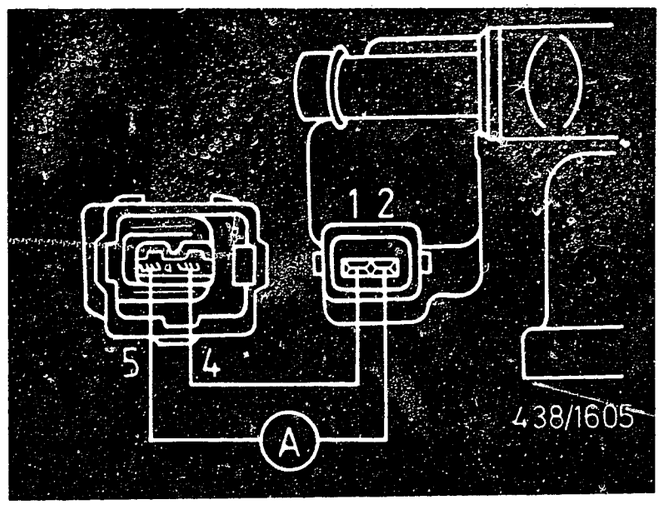
* Detach crankcase breather hose at breather housing (on engine block).

* Remove CO anti-tamper safeguard (plug) at KE-air flow sensor with special tool kit (e.g. Hazet tool kit 4521/7).

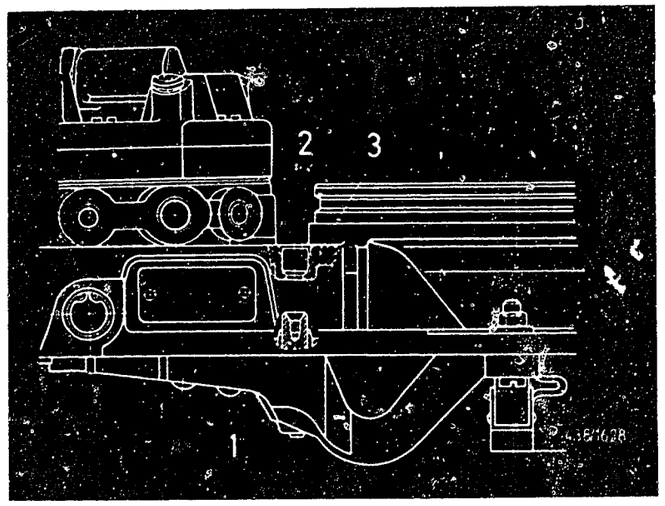
Start engine and run at idle. Adjust pressure-actuator control current if necessary by adjusting the idle-mixture-adjusting screw in the mixture-control unit (bottom picture).

Anti-clockwise direction: increased current
Clockwise direction: reduced current

Note: the CO value is a reference value and results automatically given closed-loop control and a correctly set current value. There is no possibility of adjustment.



1 = Idle-mixture-adjusting screw
2 = Plug
3 = KE-air-flow sensor



Y

Return to self-diagnosis test table B17

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (11)

SELF-DIAGNOSIS FLASHING CODE 2342

No lambda closed-loop control function

Possible causes:

* Control unit defective.

* Open-circuit in lead from control unit to lambda sensor.

* Lambda sensor heating defective (may be a possible temporary cause of fault for example in extremely cold weather and when travelling downhill for a long period).

Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (11) CONTINUED (1)

Test lambda closed-loop control function of control unit:

Pull off connector at KE pressure actuator and connect it to actuator again via test leads KDZS 0004 and KDUM 0008 such that ammeter (motortester or multimeter) can be connected (top picture).

Detatch connector of lambda sensor (center picture, arrow). Start engine and run it at idle. Static current reading approx. 0 mA.

* Hold lambda sensor lead to control unit against vehicle ground. The current reading must increase. Set value: see vehicle-specific brief instructions.

* Hold lead to control unit against positive terminal of a 1.5 V unicell and negative terminal of unicell against ground. Current reading must decrease. Set value: see vehicle-specific brief instructions.

Are both set valued obtained?

N>

Switch off engine and pull off control-unit connector.

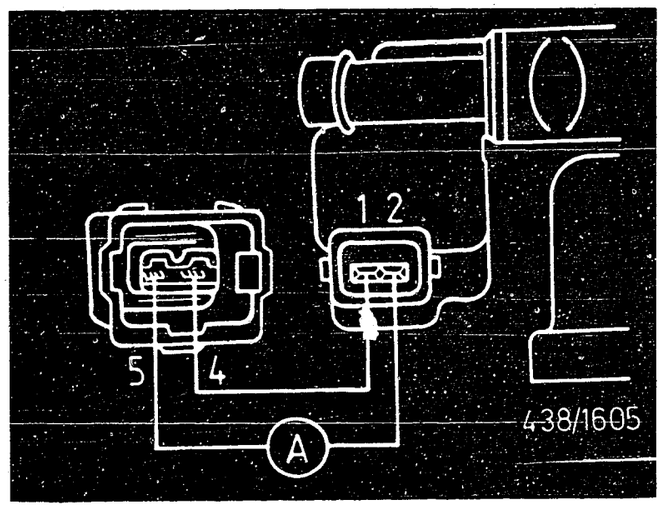
Use ohmmeter to perform continuity test on lead from term. 7 of control-unit connector to plug connection of sensor lead.

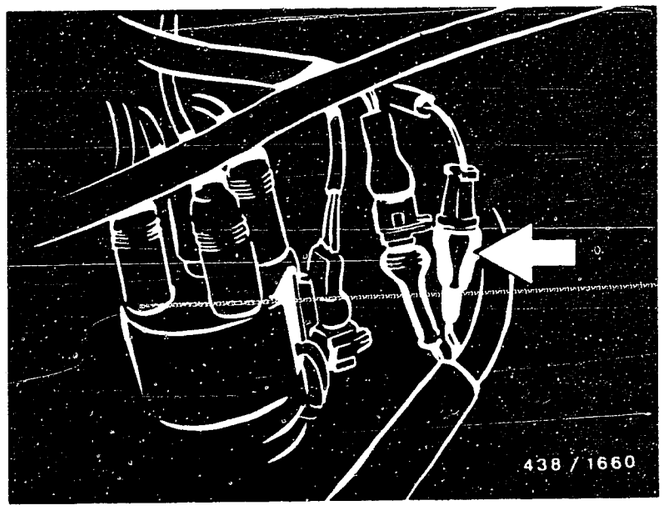
Set value: approx. 0 Ω

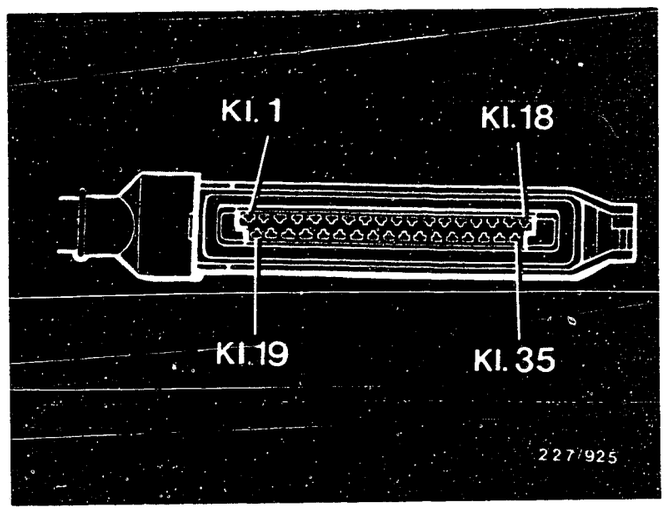
Eliminate any open-circuit.

If no open-circuit present: control unit defective, replace control unit.

Continued on next picture page







SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (11) CONTINUED (2)

Test lambda sensor:

Connect plug connection of lambda sensor (arrow).

Start engine, run it up to operating temperature (approx. 80°C) and allow it to run at idle. Take current reading.

Set value: reading fluctuating around 0 mA

O.K.?

N>

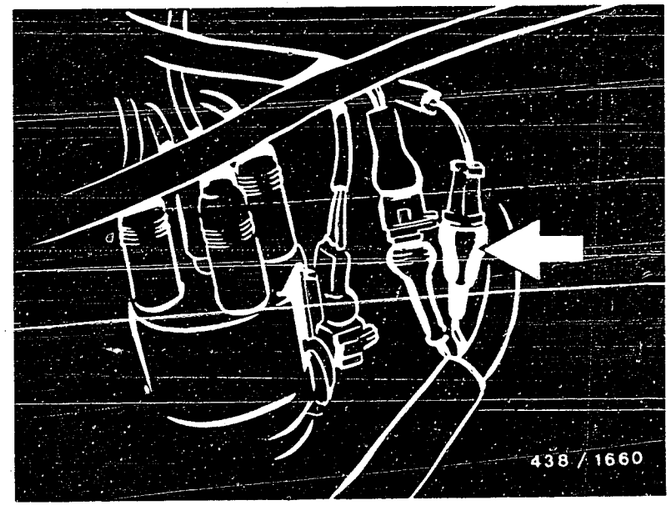
* Reading fluctuates, however mean value not about 0 mA:

 Correct CO-adjustment within scope of idle adjustment (at the end of this section).

* Current static (does not fluctuate): lambda sensor defective, replace sensor.

 Note: prior to installation, apply fitting paste VS 14016 Ft to thread of lambda sensor. Ensure that no paste gets into slots in protective conduit.

 Part number of paste: 5 964 080 112.



Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (11) CONTINUED (3)

Test lambda sensor heating:

Switch off engine.
Disconnect (arrow) 2-pole plug connection for sensor heating (next to plug connection for sensor lead).

Switch on ignition and measure voltage between both contacts at connector of sensor heating.

Set value: battery voltage.

Is set value attained?

N>

* Use ohmmeter to check lead from connector of sensor heating to fuse 24.

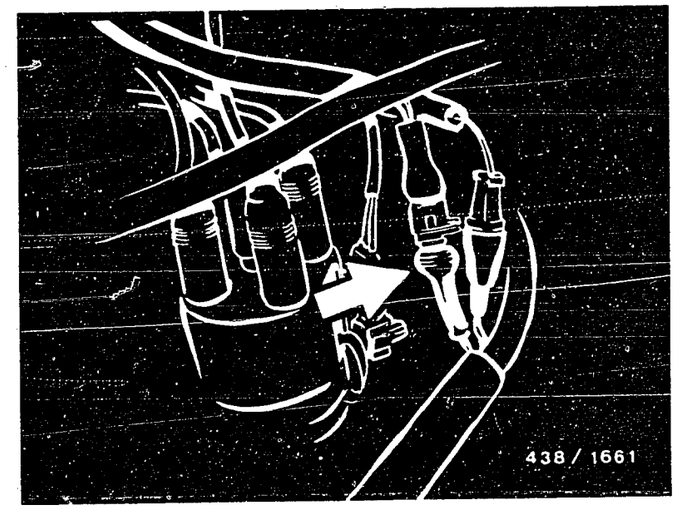
 Set value: approx. 0 Ω

 Eliminate any open-circuit.

* If O.K., perform continuity test on lead from connector of sensor heating to vehicle ground.

 Set value: approx. 0 Ω

 Eliminate open-circuit.



Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (11) CONTINUED (4)

Use ohmmeter to measure internal resistance of lambda sensor heating at sensor half of connector (top picture, arrow).

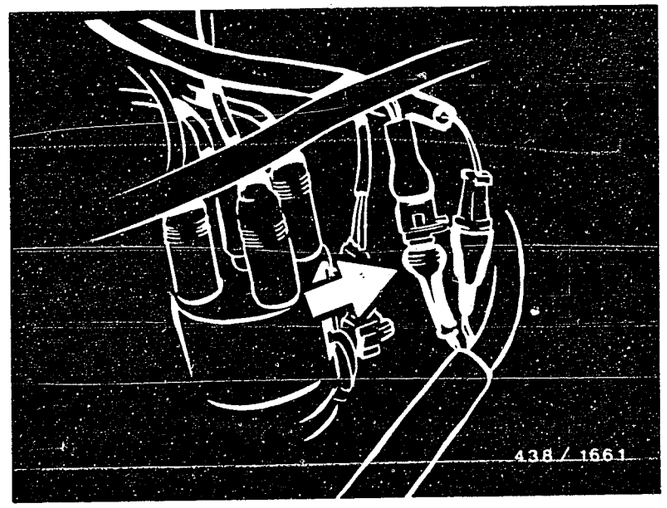
Set value: 1...15 Ω

O.K.?

N>

Replace lambda sensor.

Note: prior to fitting, apply fitting paste VS 14016 Ft to thread of lambda sensor. Ensure that no paste gets into slots in protective conduit.



Continued on next picture page

F11 — <==> F12 — <==>

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (11) CONTINUED (5)

Test idle adjustment:

Test prerequisites:

* Engine oil temperature min. 80° C.

* Electrical loads switched off (cooling fan must not run during testing/adjustment).

* A/C switched off.

* Pressure gauge KDJE-P 100 not connected.

* Exhaust system must not leak.

Continued on next picture page

Test procedure:

Connect ammeter (motortester or multimeter) with test lead KDZS 0004 and KDUM 0008 to KE-pressure actuator of fuel distributor (top picture).

Tightly connect exhaust sampling hose of exhaust-gas analyzer to CO-measuring pipe.

Run engine at idle speed.

Idle-speed set value: see vehicle-specific brief instructions.

Note: speed cannot be adjusted; automatically regulated.

Set value for CO-content: see vehicle-specific brief instructions.

Fluctuating pressure-actuator control current (lambda closed-loop control in operation).

Set value: see vehicle-specific brief instructions.

Are both set values obtained?

N>

Idle adjustment:

* Pull cap off activated-carbon canister.

* Detach crankcase breather hose at cylinder head cover and seal it tight.

* Detach crankcase breather hose at breather housing (on engine block).

* Remove CO anti-tamper safeguard (plug) at KE-air flow sensor with special tool kit (e.g. Hazet tool kit 4521/7).

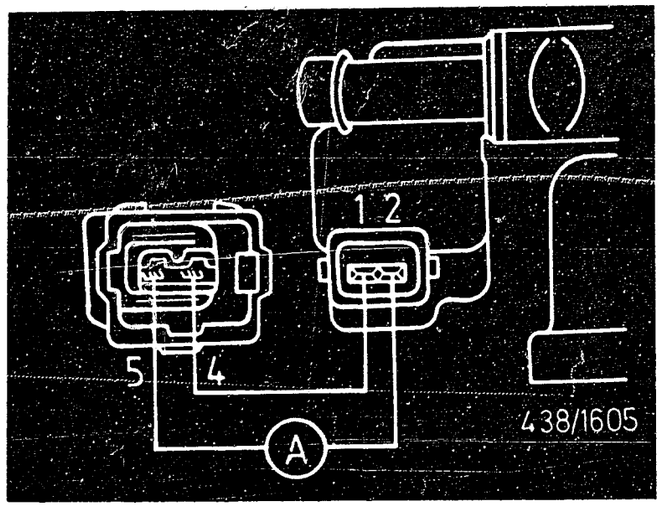
Start engine and run at idle. Adjust pressure-actuator control current if necessary by adjusting the idle-mixture-adjusting screw in the mixture-control unit (bottom picture).

Anti-clockwise direction: increased current
Clockwise direction: reduced current

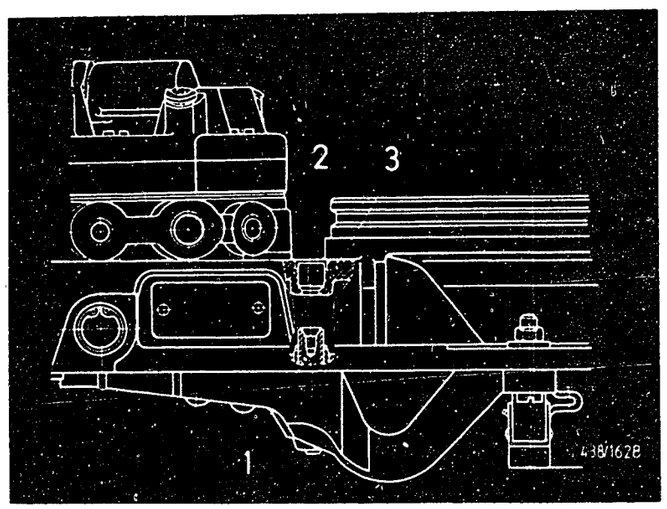
Note: the CO value is a reference value and results automatically given closed-loop control and a correctly set current value. There is no possibility of adjustment.

Y

Return to self-diagnosis test table B19



1 = Idle-mixture-adjusting screw
2 = Plug
3 = KE-air-flow sensor



SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (12)

SELF-DIAGNOSIS FLASHING CODE 2343

Engine setting too lean, mixture control limit +10 mA ("rich") exceeded.

Possible causes:

* Engine intake system leaking (leakage air).

* Incorrect idle adjustment (too lean).

Note: indication not given by diagnosis lamp lighting up continuously; fault storage only.

Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (12) CONTINUED (1)

V

Check air-intake system of engine for leaks:

The arrows in the picture indicate the typical points at which leaks may occur. Check by visual examination or, if unsure, as follows:

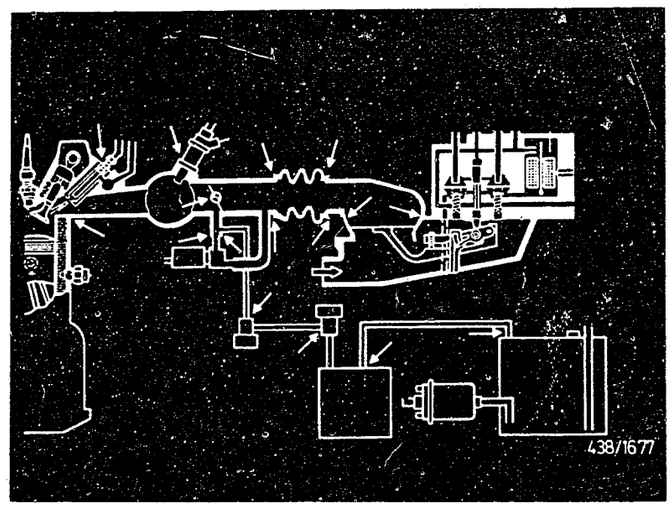
Disconnent hose from outlet of idle actuator and, using a compressed-air gun, blow air into the air-routing system through this hose. Open throttle-valve fully when doing this. Brush or spray joints with soapy water or with leak-detector spray (e.g. GÜpoflex).

Under no circumstances may combustible liquids be used for testing for leaks.

Bubbling or foaming indicates a leak.

Air-intake system leak-tight?

N> Eliminate leaks in air-intake system.



Y

V

Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (12) CONTINUED (2)

Test idle adjustment:

Test prerequisites:

* Engine oil temperature min. 80° C.

* Electrical loads switched off (cooling fan must not run during testing/adjustment).

* A/C switched off.

* Pressure gauge KDJE-P 100 not connected.

* Exhaust system must not leak.

Continued on next picture page

Test procedure:

Connect ammeter (motortester or multimeter) with test lead KDZS 0004 and KDUM 0008 to KE-pressure actuator of fuel distributor (top picture).

Tightly connect exhaust sampling hose of exhaust-gas analyzer to CO-measuring pipe.

Run engine at idle speed.

Idle-speed set value: see vehicle-specific brief instructions.

Note: speed cannot be adjusted; automatically regulated.

Set value for CO-content: see vehicle-specific brief instructions.

Fluctuating pressure-actuator control current (lambda closed-loop control in operation).

Set value: see vehicle-specific brief instructions.

Are both set values obtained?

N>

Idle adjustment:

* Pull cap off activated-carbon canister.

* Detach crankcase breather hose at cylinder head cover and seal it tight.

* Detach crankcase breather hose at breather housing (on engine block).

* Remove CO anti-tamper safeguard (plug) at KE-air flow sensor with special tool kit (e.g. Hazet tool kit 4521/7).

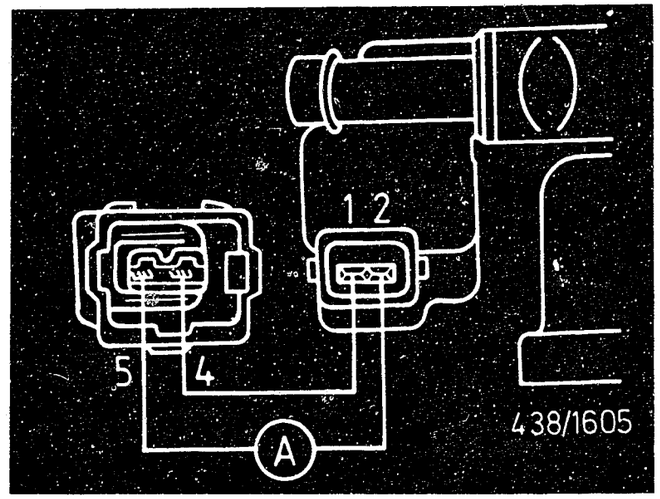
Start engine and run at idle. Adjust pressure-actuator control current if necessary by adjusting the idle-mixture-adjusting screw in the mixture-control unit (bottom picture).

Anti-clockwise direction: increased current
Clockwise direction: reduced current

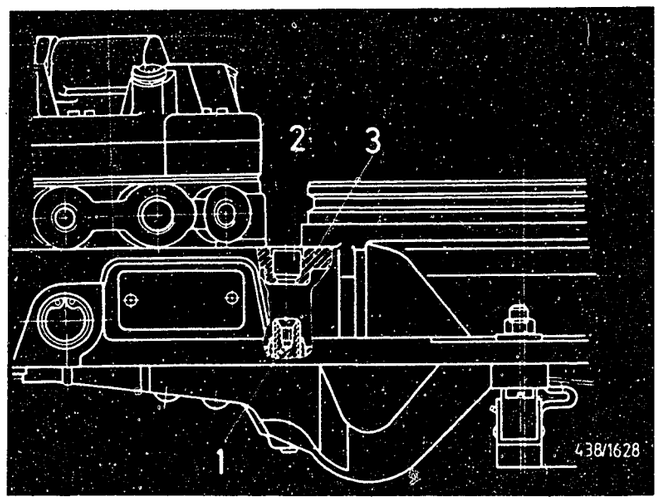
Note: the CO value is a reference value and results automatically given closed-loop control and a correctly set current value. There is no possibility of adjustment.

Y

Return to self-diagnosis test table B10



1 = Idle-mixture-adjusting screw
2 = Plug
3 = KE-air-flow sensor



SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (13)

SELF-DIAGNOSIS FLASHING CODE 2344

Engine adjustment too rich, mixture control limit -5 mA ("lean") dropped below.

Possible causes:

* Start valve leaking.

* Incorrect idle adjustment (too rich).

Note: indication not given by diagnosis lamp lighting up continuously; fault storage only.

Continued on next picture page

F25 — <⟹>

F26 — <⟹>

V

Test start valve for leaks:

Remove start valve.
The fuel line remains connected.
Do not bend or damage line.

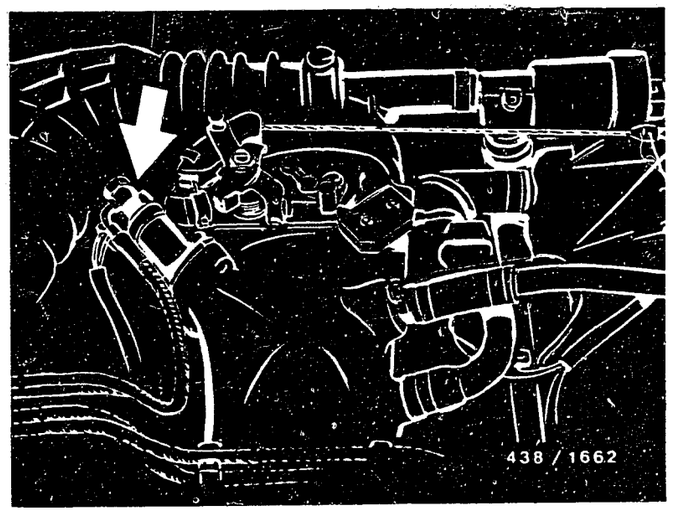
Switch on electric fuel pump by bridging the safety circuit.
To do so, detach relay in central-electrics console, relay position 10, and jump contacts 48 and 52 with auxiliary lead.

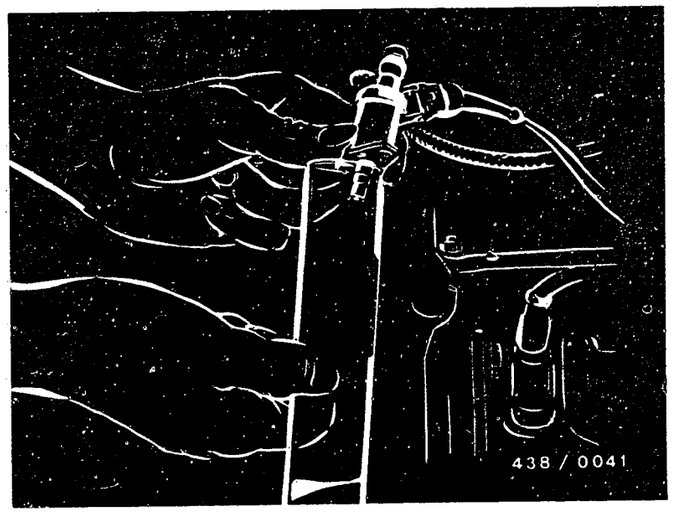
Clean nozzle of start valve.
No droplet may drip off at the nozzle within one minute.
The start valve must be leak-proof even when shaken and knocked.

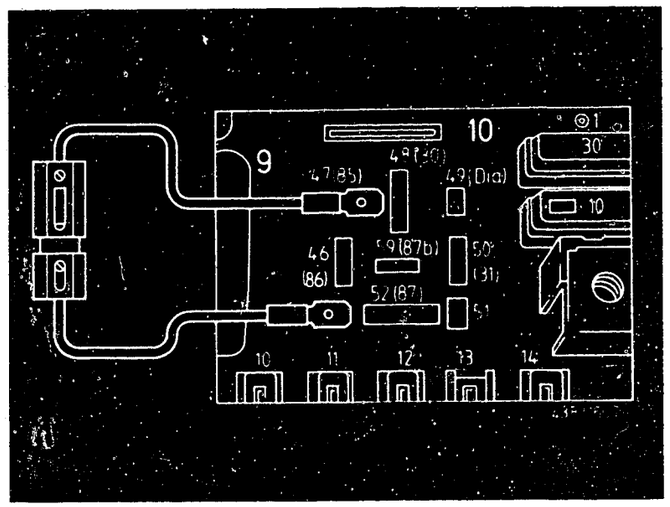
N>

Replace leaking start valve.

Note: if the start valve had to be replaced on account of a leak, the idle adjustment must be checked and corrected if necessary (following coordinate).







V

Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (13) CONTINUED (2)

Test idle adjustment:

Test prerequisites:

* Engine oil temperature min. 80° C.

* Electrical loads switched off (cooling fan must not run during testing/adjustment).

* A/C switched off.

* Pressure gauge KDJE-P 100 not connected.

* Exhaust system must not leak.

Continued on next picture page

G01 — <⟹>

G02 — <⟹>

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (13) CONTINUED (3)

V

Test procedure:

Connect ammeter (motortester or multimeter) with test lead KDZS 0004 and KDUM 0008 to KE-pressure actuator of fuel distributor (top picture).

Tightly connect exhaust sampling hose of exhaust-gas analyzer to CO-measuring pipe.

Run engine at idle speed.

Idle-speed set value: see vehicle-specific brief instructions.

Note: speed cannot be adjusted; automatically regulated.

Set value for CO-content: see vehicle-specific brief instructions.

Fluctuating pressure-actuator control current (lambda closed-loop control in operation).

Set value: see vehicle-specific brief instructions.

Are both set values obtained?

N>

Idle adjustment:

* Pull cap off activated-carbon canister.

* Detach crankcase breather hose at cylinder head cover and seal it tight.

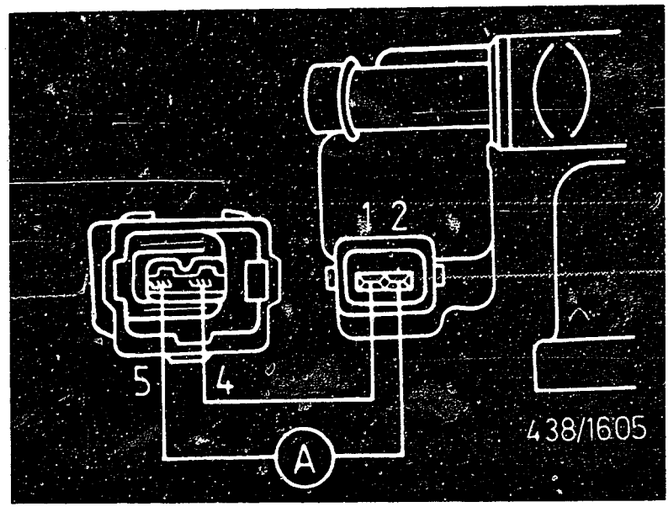
* Detach crankcase breather hose at breather housing (on engine block).

* Remove CO anti-tamper safeguard (plug) at KE-air flow sensor with special tool kit (e.g. Hazet tool kit 4521/7).

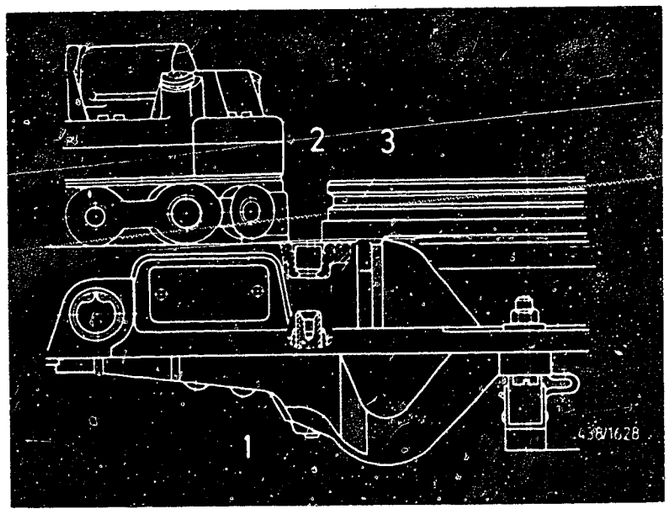
Start engine and run at idle. Adjust pressure-actuator control current if necessary by adjusting the idle-mixture-adjusting screw in the mixture-control unit (bottom picture).

Anti-clockwise direction: increased current
Clockwise direction: reduced current

Note: the CO value is a reference value and results automatically given closed-loop control and a correctly set current value. There is no possibility of adjustment.



1 = Idle-mixture-adjusting screw
2 = Plug
3 = KE-air-flow sensor



Y

Return to self-diagnosis test table B19

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (14)

SELF-DIAGNOSIS FLASHING CODE 4431

No idle-speed control function.

Possible causes:

* Power supply (ignition, term. 15) to idle actuator, term. 2 interupted.

* Open-circuit or short-circuit to ground in lead from control unit, term. 17 to idle actuator, term.1.

* Idle actuator defective (open-circuit).

* Control unit defective.

Note: indication not given by diagnosis lamp lighting up continuously; fault storage only.

Continued on next picture page

SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (14) CONTINUED (1)

Test power supply for idle actuator:

Pull off connector at idle actuator
(top picture, arrow)

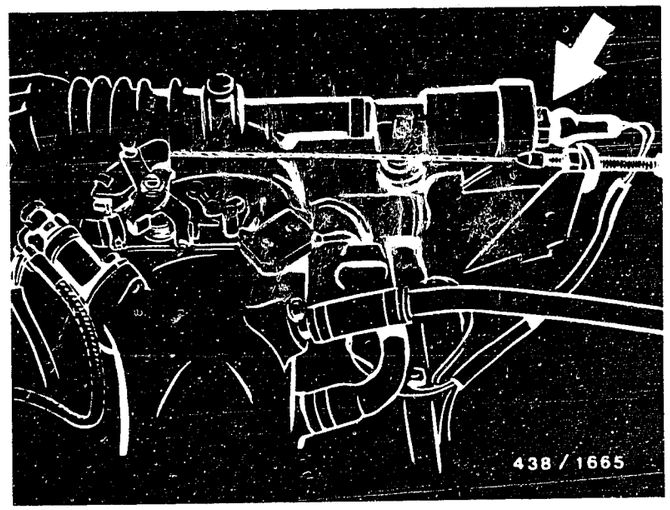
Switch on ignition.

Perform voltage measurement at connector, term. 2
to ground.

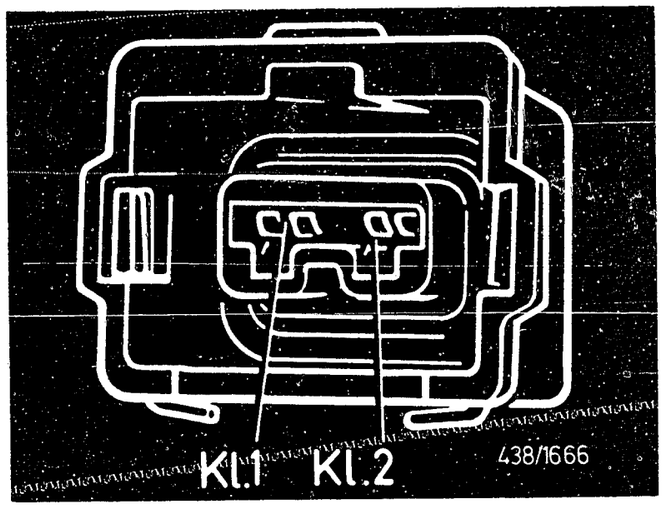
Set value: battery voltage.

O.K.?

N> Eliminate open-circuit in lead from ignition switch via fuse 24 to connector of idle actuator, term. 2.



Continued on next picture page



SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (14) CONTINUED (2)

Check actuation lead from control unit to idle actuator for continuity/short-circuit to ground:

Switch off ignition and detach control-unit connector.

Use ohmmeter to perform continuity test on lead from control-unit connector, term. 17 to connector of idle actuator, term. 1.

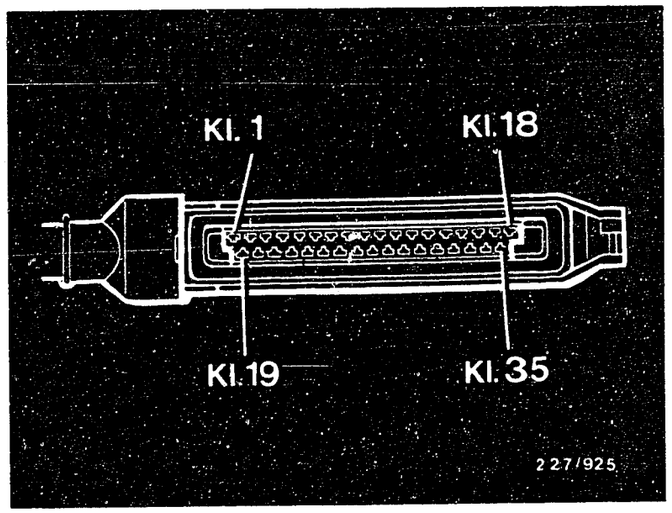
Set value: approx. 0 Ω

Connect ohmmeter to term. 17 of control-unit connector and engine ground.

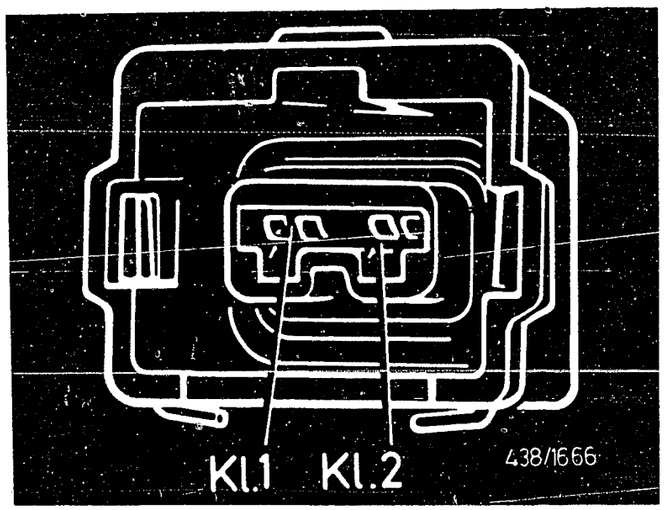
Set value: infinity Ω

Both values O.K.?

N> Eliminate any open-circuit in lead or short-circuit to ground.



Continued on next picture page



SELF-DIAGNOSIS TROUBLE-SHOOTING PROGRAM (14) CONTINUED (3)

Test internal resistance of idle-actuator winding:

Connect ohmmeter to the two terminal posts of the idle actuator.

Set value: see vehicle-specific brief instructions.

Connect ohmmeter to one of the two terminal posts and to engine ground.

Set value: infinity Ω

Both values O.K.?

N> Replace idle actuator.

Y

The control unit is defective if no fault was established in the previously listed tests under flashing code 4431.

Replace control unit.

Y

Return to self-diagnosis test table B19

G11 — <⟹>

G12 — <⟸

TROUBLE-SHOOTING PROGRAM (1)

V

VOLTAGE SUPPLY
CONTROL UNIT:

Pin assignment, control unit:

Term. 14 = supply, ignition switch, term. 15.

Term. 19 = continuous supply U Bat. (term. 30) for permanent memory.

Term. 18 = control unit - ground.

Term. 35 = control unit - ground.

Detach control-unit connector with ignition switched off.

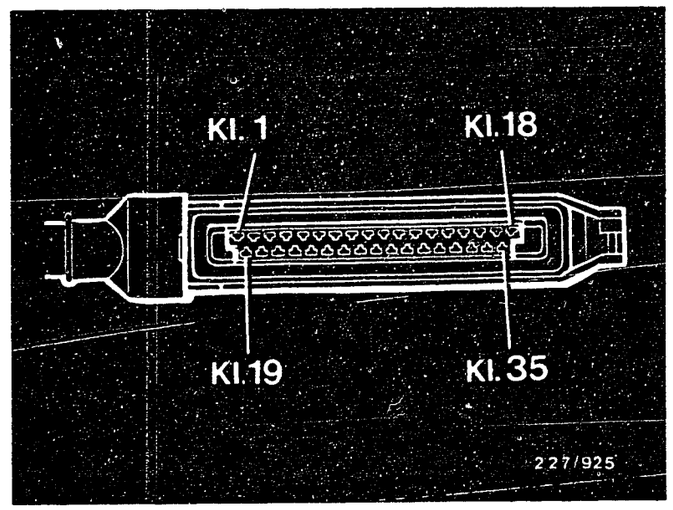
Switch on ignition.

Perform voltage measurement at control-unit connector term. 14 and ground.

Set value: battery voltage.

O.K.?

N> Eliminate open-circuit in lead from ignition switch via fuse 28 to control unit, term. 14.



Y

V

Continued on next picture page

TROUBLE-SHOOTING PROGRAM (1) CONTINUED (1)

Switch off ignition.

Voltage measurement at control-unit connector, term. 19 and ground.

Set value: battery voltage.

O.K.?

N> Eliminate open-circuit in lead between central-electrics console and control-unit connector, term. 19.

Y

Resistance measurements between control-unit connector, term. 18 and term. 35, and engine ground:

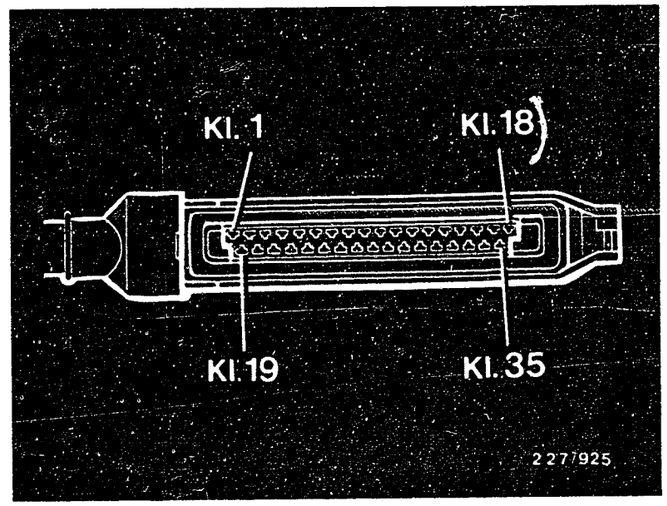
Set value: approx. 0 Ω in each case

O.K.?

N> Eliminate open-circuit in lead from control-unit connector, term. 18/term. 35 to engine ground - ground point, intake manifold -

Y

Return to trouble-shooting chart B03



G15 — <==>

G16 — <==>

ELECTRIC FUEL PUMP, ACTUATION (SAFETY CIRCUIT) AND FUNCTION.

N>

1. Actuation:

The electric fuel pump must start up approx. 1 s following switch-on of the ignition and then switch off insofar as starting does not then take place immediately. After starting, the pump must continue to run. This safety function is determined by the control unit which actuates the pump relay.

Perform the following tests in the stipulated order until the fault is established:

* Lead connections at relay base:

 Voltage measurements, set values:

 Term. 48 (30) and ground = battery voltage

 Term. 46 (15) and ground, switch on ignition = battery voltage

 Resistance measurements, set values, between:

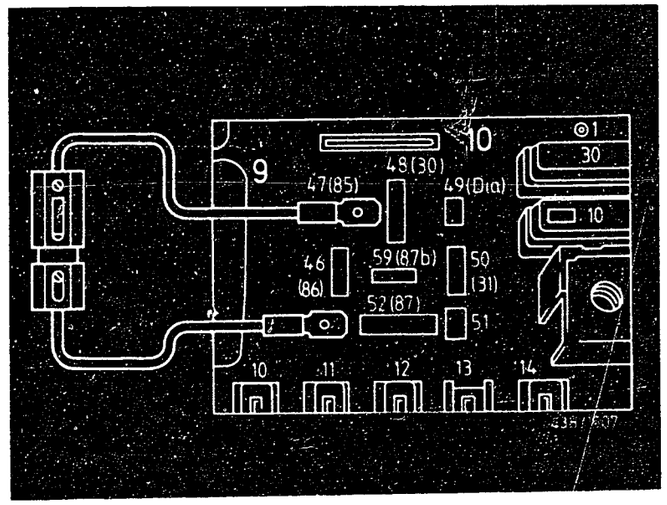
 Term. 52 (87) and electric fuel pump = approx. 0 Ω

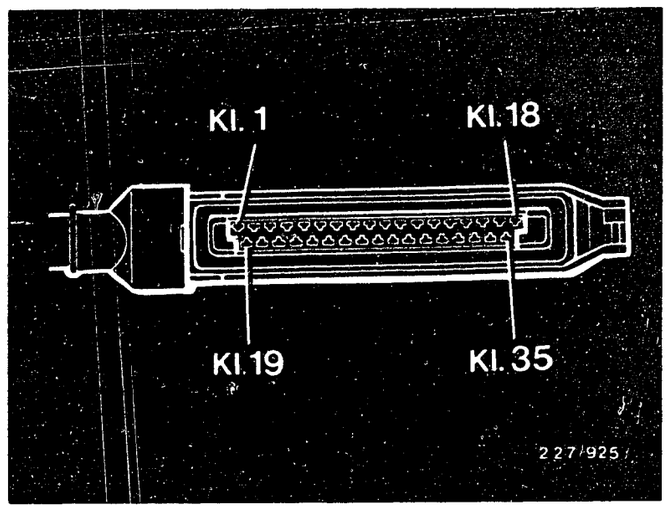
 Ground lead of electric fuel pump and vehicle ground = approx. 0 Ω

 Pull off control-unit connector with ignition switched off.

 Term. 47 (85) and control-unit connector, term. 12 = approx. 0 Ω

 Eliminate any open-circuit in lead.





Continued on next picture page

Continued on next picture page

V

* If there is no fault in the lead:

 Jump term. 48 (30) and 52 (87) in relay base with auxiliary lead (with fuse element and fuse 16 A). Electric fuel pump must run.

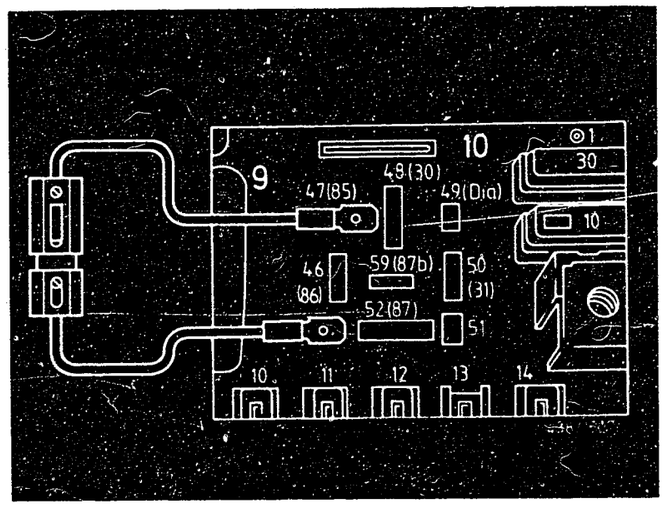
 No function:
 electric fuel pump defective. Replace pump (description at end of this test section).

* Connect term. 12 to term. 18 on control-unit connector.

 Switch on ignition. Electric fuel pump must run.

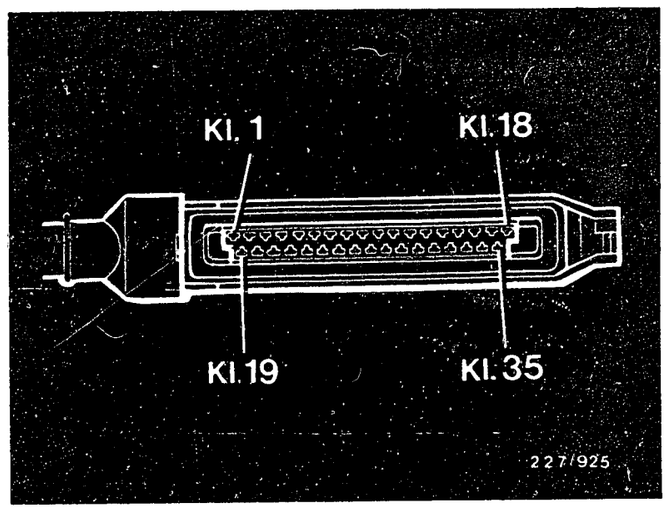
 No function: relay defective. Replace relay.

* If O.K.: control unit defective. Replace control unit.



V

Continued on next picture page



TROUBLE-SHOOTING PROGRAM (2) CONTINUED (2)

2. Check operation of electric fuel pump. N>

This tests the fuel delivery against primary pressure, i.e. at the fuel return line from the primary-pressure regulator to the fuel tank.

Undo screw connector in return line (arrow in top picture) and hold flexible hose end in measuring glass (approx. 1.5 liter capacity).

Switch on electric pump for precisely 30 seconds by jumping the safety circuit, and measure fuel delivery in measuring glass.

Set value: see vehicle-specific breif instructions.

Set value obtained?

Y

Return to trouble-shooting chart B03

Possible causes of inadequate delivery:

* Power supply of electric fuel pump not O.K., drop in voltage. Voltage measurement with pump running directly at pump connector (pull connector back somewhat, use test prods).

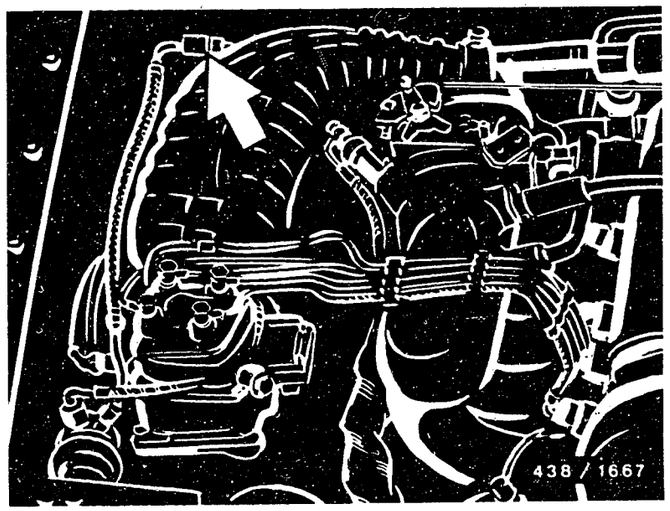
 Set value: minimum voltage 11.5 V

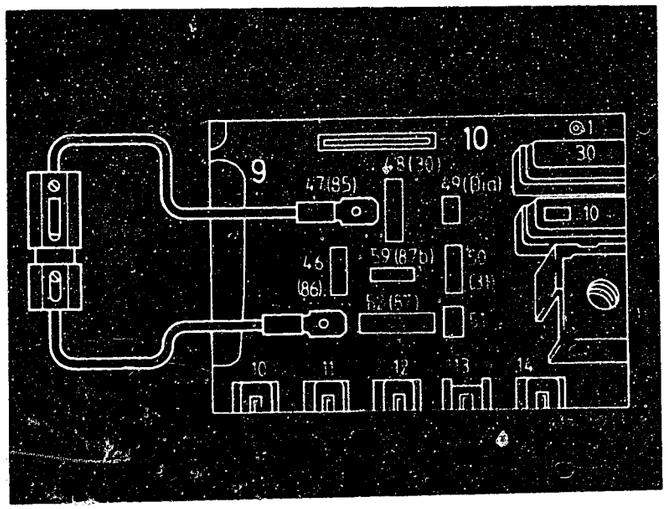
* Fuel filter extremely dirty.

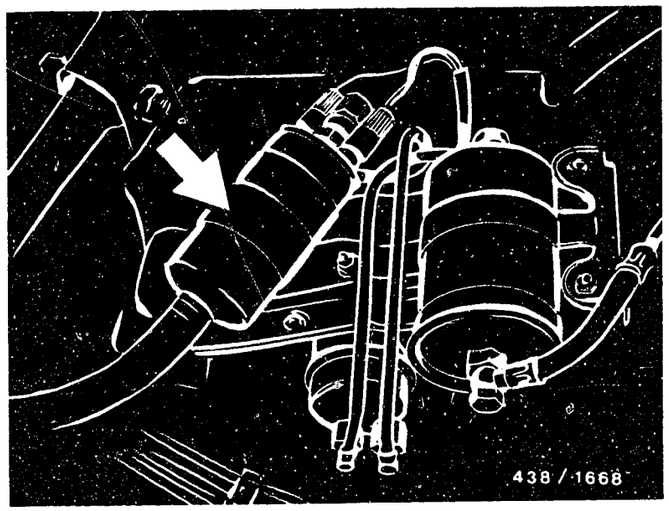
If the above-mentioned points are O.K., the cause of the fault is the electric fuel pump itself. Replace pump (bottom picture, arrow).

Removing and installing electric fuel pump:
pinch off intake hose (e.g. with pinch-off clamp W 157 manufactured by Matra), so as to prevent fuel emerging. Counter-hold fixed hexagon of electric fuel pump when detaching pressure line. Disconnect electrical connections, loosen clamping strap and remove pump.

Install pump with new sealing rings for pressure-line connections. Make sure that both fuel connections are totally free from leaks.







TROUBLE-SHOOTING PROGRAM (3)

V

AIR-FLOW SENSOR, FUEL DISTRIBUTOR, MECHANICAL TESTING AND ADJUSTMENT.

Check freedom of movement of control lever in air-flow sensor and control plunger in fuel distributor:

Important:
* Engine temperature in excess of 20°C.

* Pressure applied to control plunger (briefly switch on EFP by bridging safety circuit).

Y

V

1. Control lever:

Raise air-flow sensor plate by hand and release. Plate jumps back into zero position and jumps off the spring-loaded stop about two more times.

N>

If it does not move freely, first loosen all fastening screws of air-flow sensor to establish whether housing torsion is the cause. If this eliminates the stiffness, replace seal between air-filter housing and air-flow sensor (Audi spare part).

When fitting, do not apply any sealing compound between the sealing surfaces.

Tightening torque of air-flow-sensor fastening screws = 9...10 Nm.

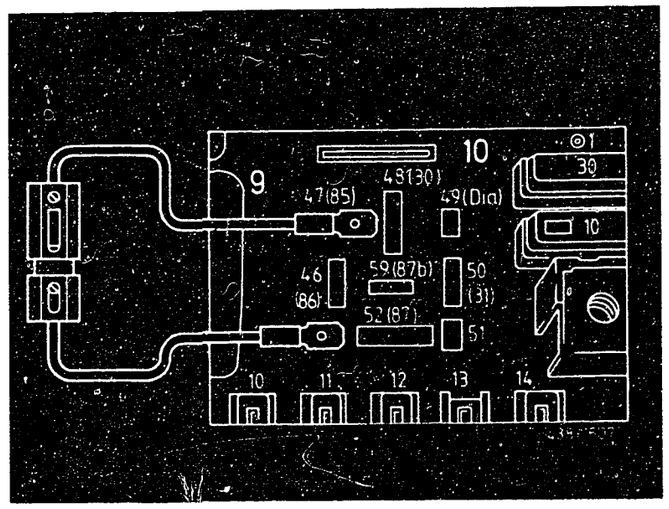
If housing torsion is not the cause, replace air-flow sensor.

With the KE-Motronic the air-flow sensor cannot be repaired!

Y

V

Continued on next picture page



2. Control plunger:

Raise sensor plate by hand. Uniform resistance must be felt over the entire travel. Move sensor plate back quickly to just before the zero position. The plunger slowly follows this movement and must be felt to come to rest on the control lever.

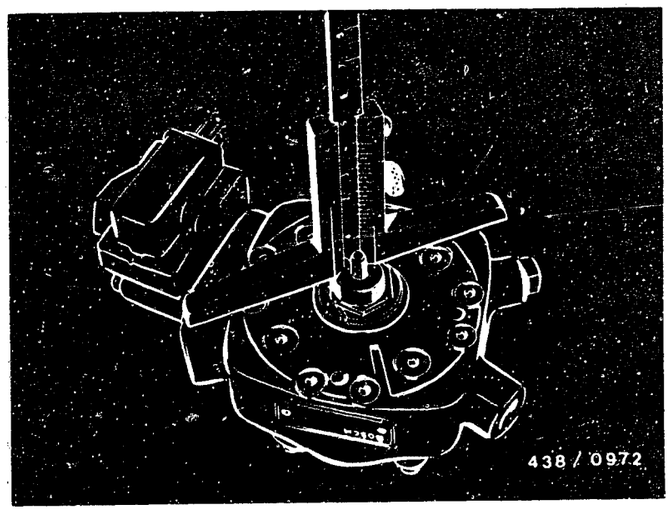
N>

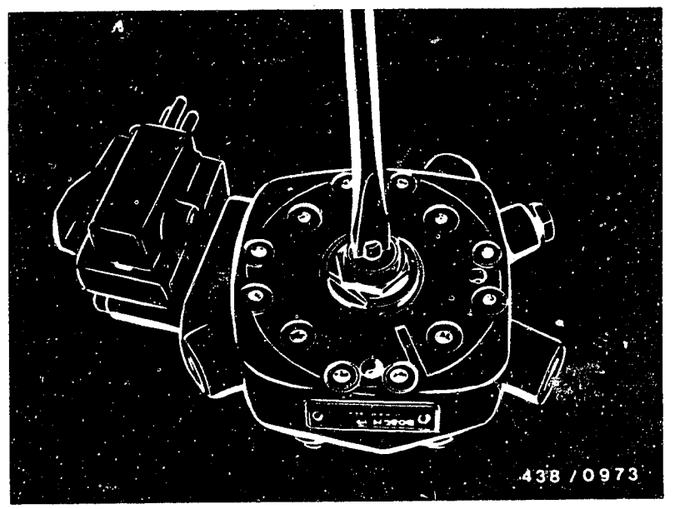
If control plunger stiff, remove fuel distributor from air flow sensor. To do this, roughly clean fuel distributor in area of fuel connections and unscrew all connections. When loosening and subsequently tightening the fuel lines, hold the fixed hexagonal section of the component with a wrench. Unscrew three fastening screws and remove fuel distributor.

Using a depth gauge, measure position of lower slotted round nut of plunger seal in relation to hexagon nut, and note down. In addition, mark rotary position of slotted round nut. Unscrew slotted round nut and remove plunger.

Clean plunger with benzine or similar. If plunger has severe score marks or if freedom of movement cannot be obtained by cleaning, replace fuel distributor. Mechanical cleaning of plunger is not allowable.







Continued on next picture page

Continued on next picture page

After installing the control plunger in the fuel distributor, screw in slotted round nut of plunger seal as far as the position noted when removing, and turn to the marked position.

Mount fuel distributor with new seal ring on air-flow sensor. Tightening torque for the three fastening screws: 3.2...3.8 Nm

Continued on next picture page

Centering the sensor plate:

Check whether the sensor plate is flat (not bent) and whether it can move through without contact at the narrowest point of the air funnel.

N>

Replace bent sensor plate or re-center sensor plate:

Loosen fastening screw:

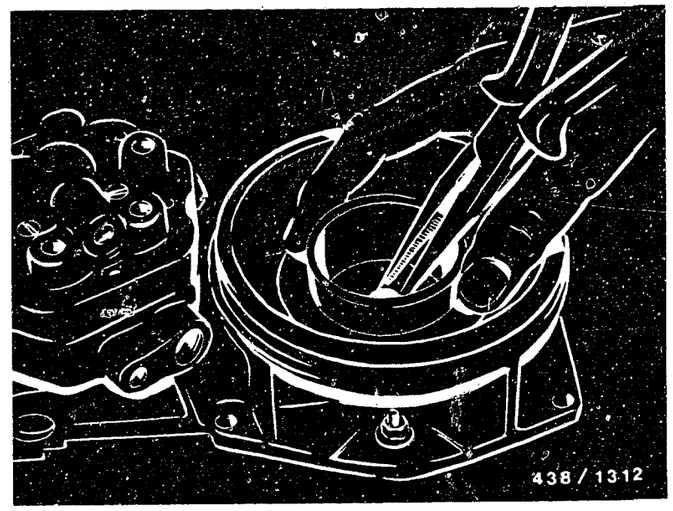
Caution: to lock it, the screw was micro-encapsulated at the factory and is therefore difficult to loosen and turn. If screw is very tight, do not turn by force, but heat with a large soldering iron or with a hot-air fan.

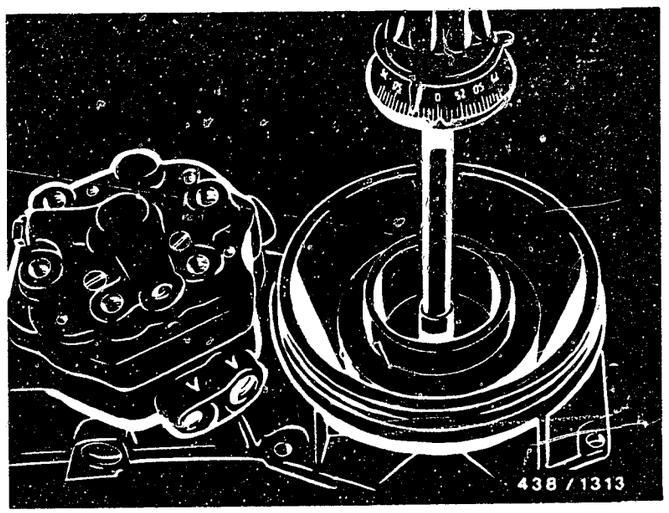
DO NOT USE AN OPEN FLAME!

Center air-flow sensor plate with locating ring KDEP 1040/10 (80 mm) as follows:

Insert sensor plate with locating ring so that it is in the cylindrical area of the air funnel. Tighten fastening screw to 5...5.5 Nm.

Note: If the screw is very easy to turn (after being loosened several times), clean it and coat it with a little screw-locking compound (e.g. Loctite). Do not use too much in order to enable subsequent loosening. After tightening to the specified tightening torque, it must no longer be possible to turn the sensor plate.





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TROUBLE-SHOOTING PROGRAM (3) CONTINUED (4)

Position of sensor plate (zero position): (see also sticker on sensor plate)

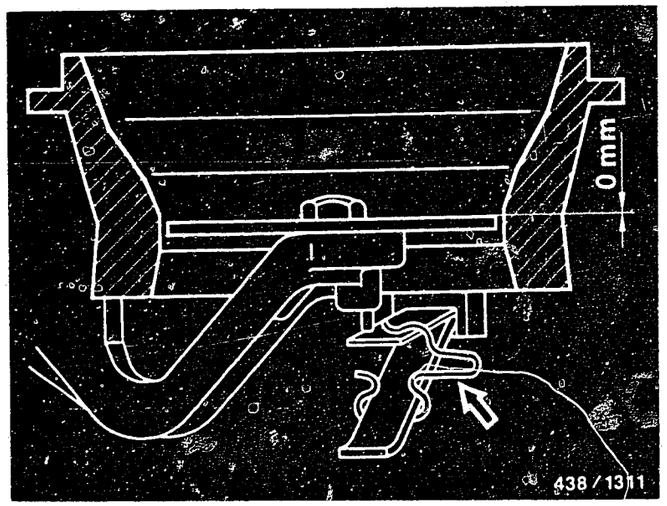
The starting point for the zero position is the basic position of the sensor plate. Definition of basic position: to edge of sensor plate flush with transition edge between cylindrical area and air funnel (visual examination, see picture).

Hold sensor plate in basic position (possibly from below through air-filter housing) and, using a depth gauge, measure distance between top edge of air funnel and sensor plate (at rim, in direction of fuel distributor.

Then lower sensor plate as far as stop spring. This "zero position" should be lower than the basic (position according to the value on the sticker (e.g. 1.9 + 1.1mm).

N>

If necessary, correct position of stop leaf spring and thus zero position by adjusting spring at lower sensor-plate stop bracket (see picture, arrow).



Continued on next picture page

TROUBLE-SHOOTING PROGRAM (3) CONTINUED (5)

Free travel of air-flow sensor plate:

Briefly switch on electric fuel pump by jumping the safety circuit, so that pressure is applied to the control plunger.

With the zero position correctly adjusted and the idle adjustment approximately correct, the control plunger must not rest on the needle bearing in the control lever. Check: slightly raise the sensor plate. The control lever must cover a free travel between zero position and point of contact with control plunger. This travel must be able to be felt up to max. 2 mm at the center of the sensor plate.

N>

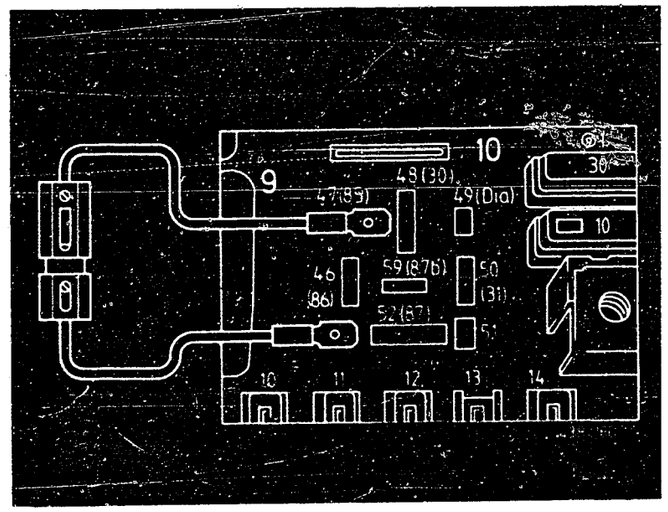
To adjust the free travel, remove fuel distributor and screw in or out the slotted round nut of the lower plunger seal.

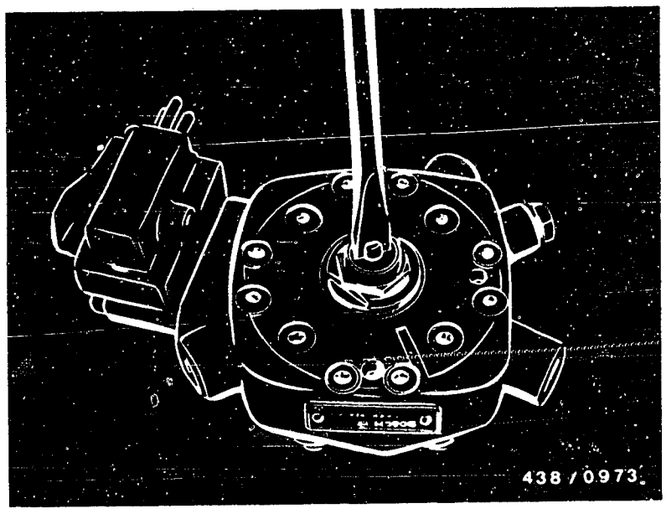
Changing the screw-in depth by 0.1 mm results in approx. 0.7 mm at the center of the sensor plate.

Special case:

Should it happen that the slotted round nut of the plunger seal and the idle-mixture-adjusting screw are both out of adjustment by an unknown amount, it is possible that the free travel may be reduced to zero or may be much too great. In this case, make an ajustment as follows:

Remove fuel distributor and turn back slotted round nut, flush with collar of hexagon nut. On the air-flow sensor, using a depth gauge, adjust the dimension between fuel-distributor support surface (threaded eyes) and needle bearing in control lever (control lever in rest position) to 21.2...21.4 mm by adjusting the idle-mixture-adjusting screw. Mount fuel distributor; there is now no free travel.





Return to trouble-shooting chart B03

Continued on next picture page

TROUBLE-SHOOTING PROGRAM (3) CONTINUED (6)

Warm up engine and carry out idle adjustment (coordinate L23).

Remove fuel distributor again and turn in slotted nut by a further approx. 0.6 mm.
Fit fuel distributor, fuel supply line only, connect both return lines and start valve line.

Check idle motion with electric fuel pump running.
If necessary, correct slotted nut accordingly with fuel distributor removed again.

Connect all lines to fuel distributor. Check idle adjustment again and correct if necessary (coordinate L23).

Return to trouble-shooting chart B03

H07 — <⟹>

H08 — <⟹>

TROUBLE-SHOOTING PROGRAM (4)

V

TESTING START VALVE:

Detach connector and temperature sensor (engine).
Connect resistor or resistance decade 15 k Ω to connector.

Remove start valve, fuel line and electrical connection remain connected. Hold start valve in a graduate.

Detach connector from power output stage at ignition coil.

Actuate starter. During actuation of starter, the start valve must provide a spray with a uniform spray pattern for a specific period.

Set value for spray time: see vehicle-specific brief instructions.

Spray function and time O.K.?

N>

1. Start valve provides spray, but time not within tolerance:

 Control unit defective.

2. Start valve does not open:

 Perform following tests until fault is established:

 * Resistance measurement at pins of start valve.

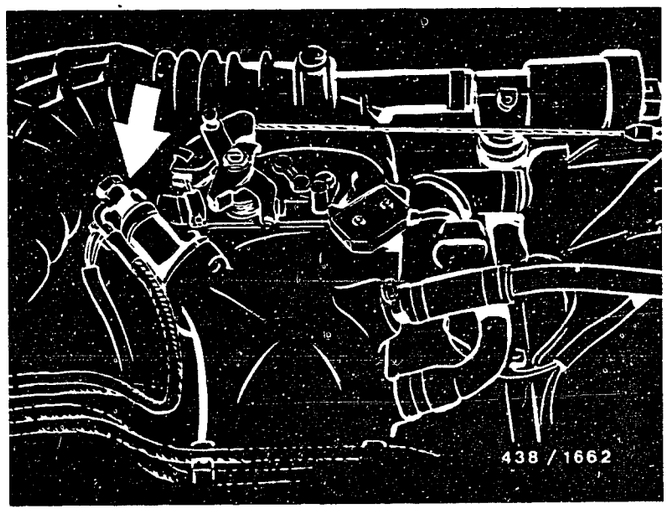
 Set value: see vehicle-specific brief instructions.

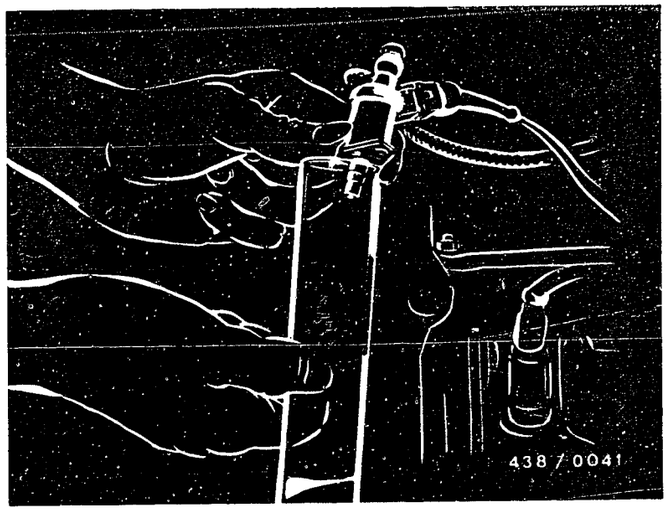
 Replace defective start valve.

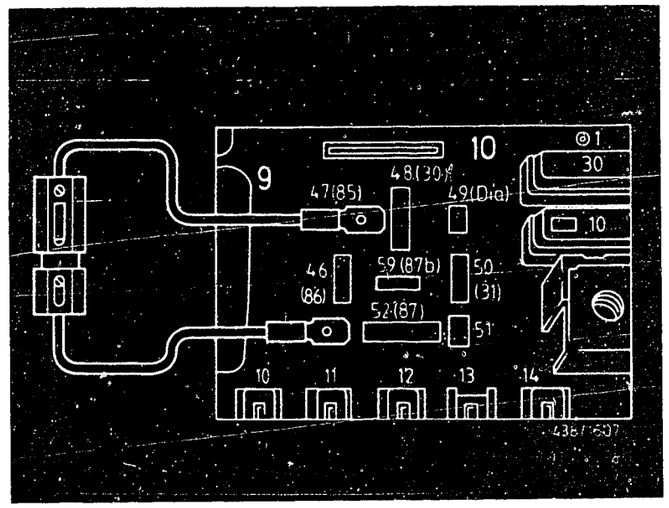
 * Switch on ignition. Voltage measurement at connector of start valve, term. 1 and ground.

 Set value: battery voltage

 Eliminate any open-circuit in lead from ignition switch via fuse 24 to start valve.







Continued on next picture page

Continued on next picture page

TROUBLE-SHOOTING PROGRAM (4) CONTINUED (1)

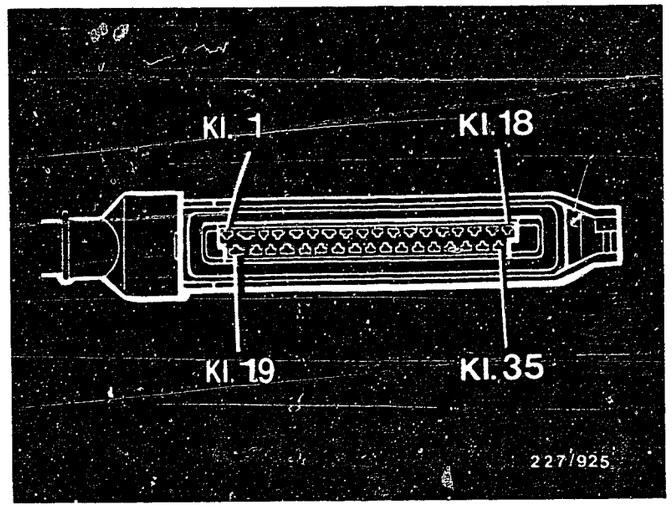
* Switch off ignition and detach control-unit connector.

 Resistance measurement between control-unit connector, term. 16 and connector of start valve, term. 1.

 Set value: approx. 0 Ω

 Eliminate any open-circuit in lead.

* If there is no fault in lead: control unit defective. Replace control unit.



Test start valve for leaks:

Dry off nozzle of start valve. No droplets may then drip off the nozzle within one minute. The start valve must remain leakproof even when shaken and knocked.

N>

Replace leaking start valve.

Note: if the start valve had to be replaced on account of a leak, the idle adjustment must be checked and corrected if necessary (following coordinate).

Return to trouble-shooting chart 803

TESTING PRIMARY PRESSURE:

Attach pressure gauge KDJE-P 100 with the aid of the connecting-element sets KDJE-P 100/10 and .../11.

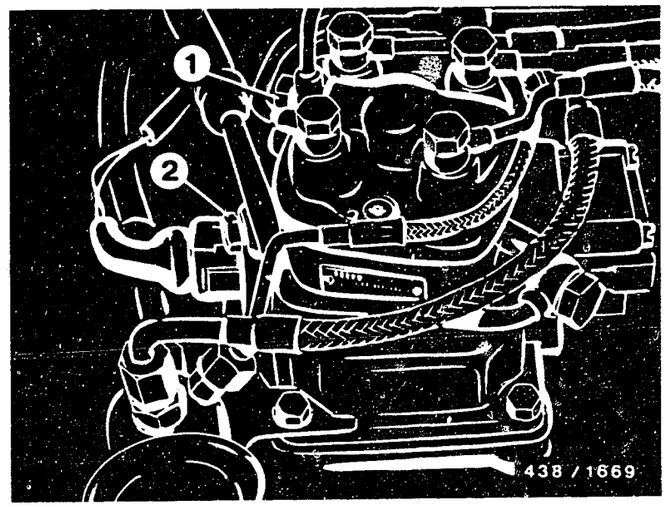
Connect measuring device to start-valve connection of fuel distributor and to special test connection in lower part of fuel distributor which is sealed with a screw plug.

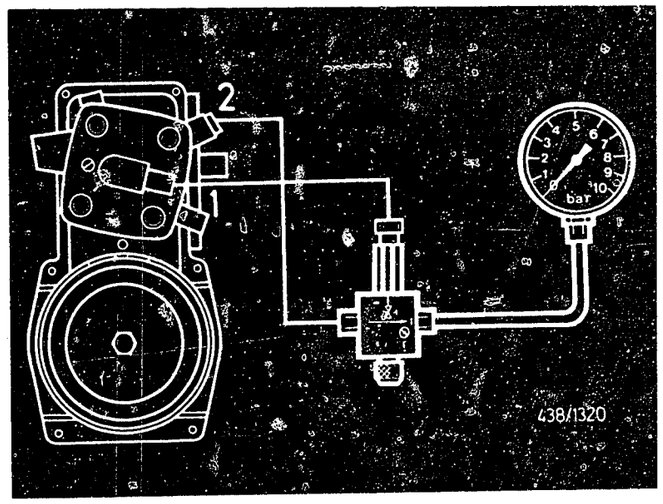
Note: to discharge residual primary pressure, always first disconnect start-valve connection (1), then lower test connection (2).

Connect port "A" of directional-control valve with double threaded connector M 8 x 1/M 12 x 1.5 from KDJE-P 100/10 to test connection.

Connect port "B" with hose from KDJE-P 100/11 to start-valve connection of fuel distributor.

Continued on next picture page





TROUBLE-SHOOTING PROGRAM (5) CONTINUED (1)

Checking the primary pressure:

Open valve screw on directional-control valve (turning counter-clockwise).

Switch on electric fuel pump by jumping the safety circuit.

Pressure gauge of pressure tester indicates primary pressure.

Set value: see vehicle-specific brief instructions.

Set value obtained?

N>

Possible causes of inadequate primary pressure:

* Fuel supply not O.K.
 Inadequate delivery from electric fuel pump.

 Measure delivery at screw connection in return line to fuel tank.

 Set value: see vehicle-specific brief instructions.

* Primary pressure regulator (diaphragm pressure regulator) not O.K.
 Replace pressure regulator.

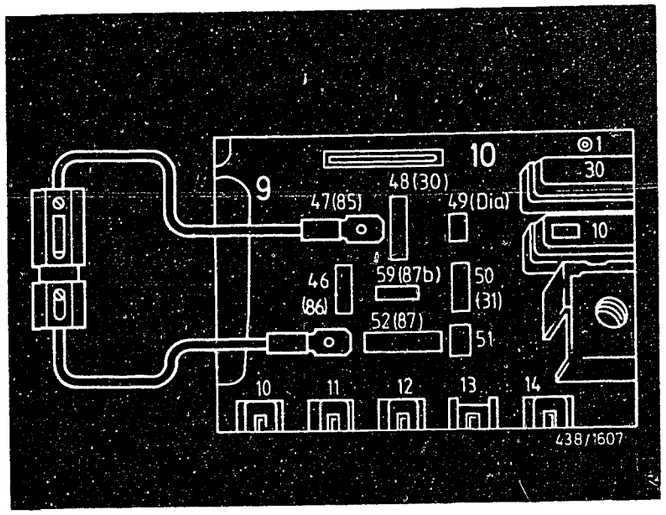
Possible causes of excessive primary pressure:

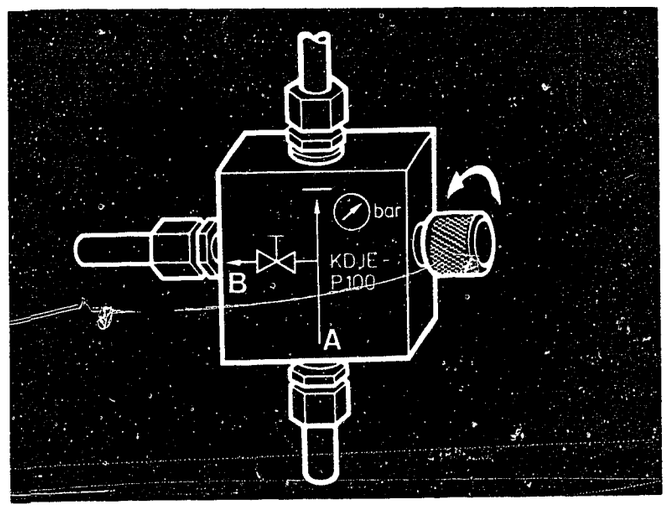
* Fuel return to fuel tank constricted. For test purposes, route return flow from pressure regulator into separate tank. If necessary, eliminate constriction.

* Primary pressure regulator (diaphragm pressure regulator) not O.K.
 Replace pressure regulator.

Y

Return to trouble-shooting chart B03





TROUBLE-SHOOTING PROGRAM (6)

V

TESTING ELECTROHYDRAULIC PRESSURE ACTUATOR AND DIFFERENTIAL PRESSURES.

Note: quantity corrections with the KE-Motronic are always effected by means of differential-pressure regulation as a function of the pressure actuator.

Differential pressure = difference between primary pressure and pressure in lower chambers of differential pressure valves.

Correct pressure-actuator operation presupposes that the electrical actuation system and the pressure actuator themselves are in proper electrical working order.

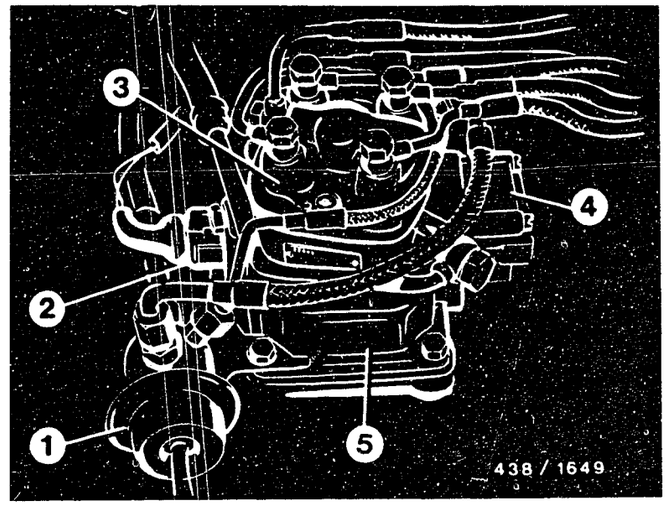
1. Electrical testing:

Connect ammeter to pressure actuator:

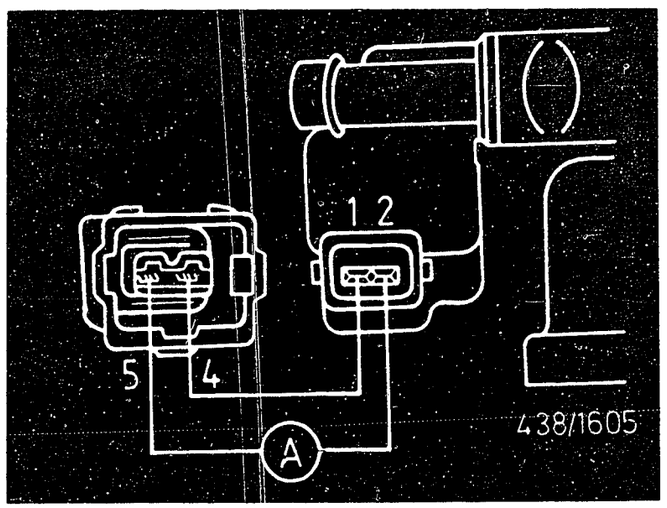
Detach connector at pressure actuator. Reconnect lead, term. 1 with auxiliary lead. Connect ammeter to term. 2 between pressure actuator and connector (test leads KDZS 0004 and KDUM 0008).

V

Continued on next picture page



4 = Pressure actuator



Set ammeter to 200 mA measuring range.

Switch on ignition.

Current reading = no-load current

Set value: see vehicle-specific brief instructions.

N>

Perform following tests in listed sequence until fault is established:

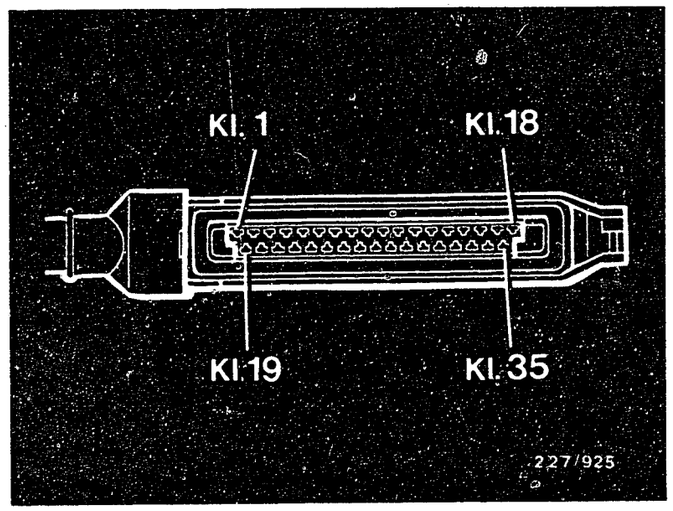
* Resistance measurement directly at the two terminals of the pressure actuator.

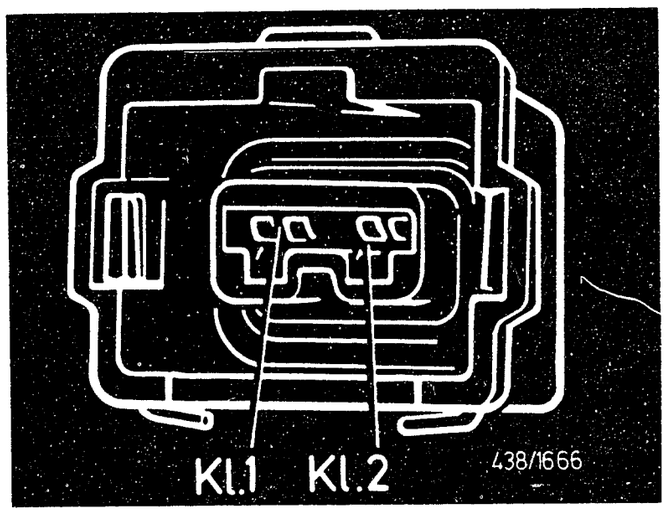
 Set value: 16...22 Ω

 If measured value not within tolerance: replace pressure actuator.

 To do so, clean fuel distributor in pressure-actuator area and unscrew pressure actuator. Always fit new pressure actuator with new sealing rings and original fastening screws (non-magnetic steel).

* Switch off ignition, detach control-unit connector. Use ohmmeter to test leads from term. 4 and term. 5 to pressure-actuator connector, term. 1 and 2 for:





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TROUBLE-SHOOTING PROGRAM (6) CONTINUED (2)

Open-circuit.
Set value: approx. 0 Ω

Short-circuit to ground.
Set value: infinity Ω

Short-circuit in both leads
Set value: infinity Ω

Eliminate any faults in lead.

* Insofar as no findings are obtained with the two tests mentioned above:

Control unit defective.

Replace control unit.

Continued on next picture page

H21 — <==>

H22 — <==>

2. Test differential pressures:

Ammeter remains connected from test 1.

Attach pressure gauge KDJE-P 100 with the aid of the connecting-element sets KDJE-P 100/10 and .../11.

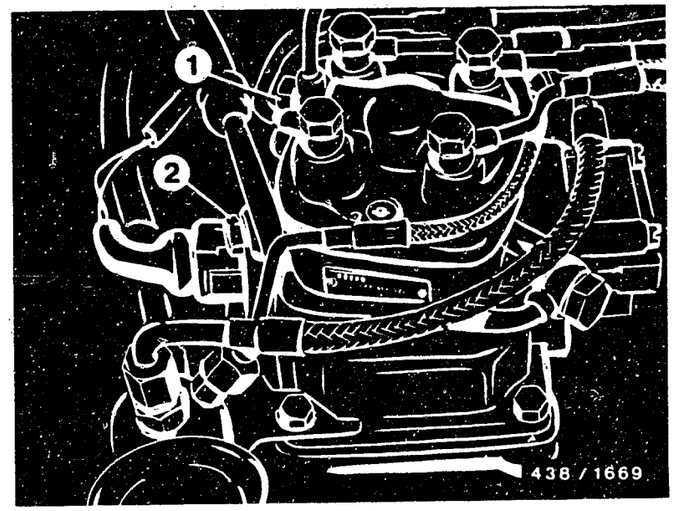
Connect measuring device to start-valve connection at fuel distributor and to special test connection in lower part of fuel distributor which is sealed with a screw plug.

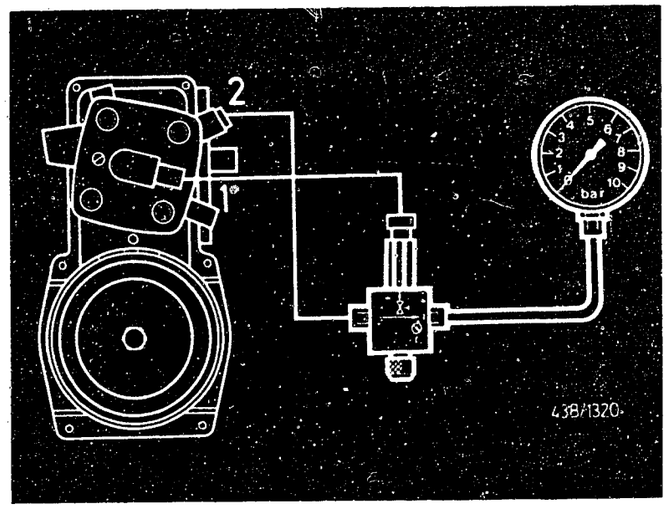
Note: to discharge residual primary pressure, always first detach start-valve connection (1), then lower test connection (2).

Connect port "A" of directional-control valve with double threaded connector M 8 x 1/M 12 x 1.5 from KDJE-P 100/10 to test connection.

Connect port "B" with hose from KDJE-P 100/11 to start-valve connection of fuel distributor.

Continued on next picture page





Testing:

(This tests the pressure difference between primary pressure and lower-chamber pressure of the differential-pressure valves in the fuel distributor)

2.1 Primary pressure:

Switch on electric fuel pump by jumping the safety circuit.

Open valve screw of directional-control valve (turning counter clockwise).

Pressure guage now indicates. primary pressure.

Set value: see vehicle-specific. brief instructions.

Make a note of the meas. value. Set value obtained?

N>

sible causes of incorrect rimary pressure:

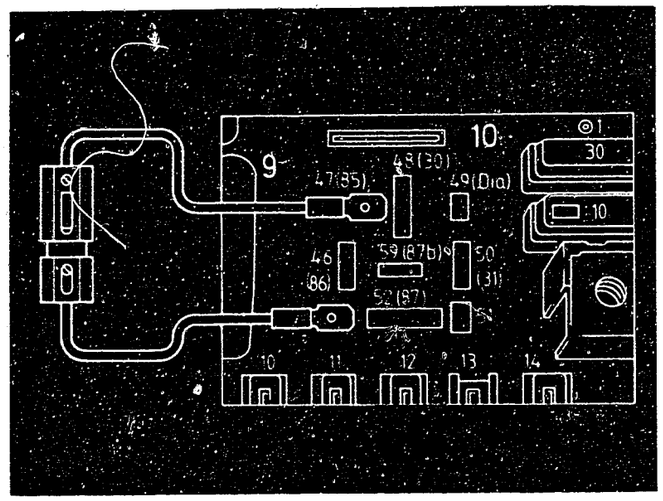
* Incorrect fuel supply, inadequate electric-fuel-pump delivery.

 Disconnect screw connection in return line to fuel tank and measure delivery.

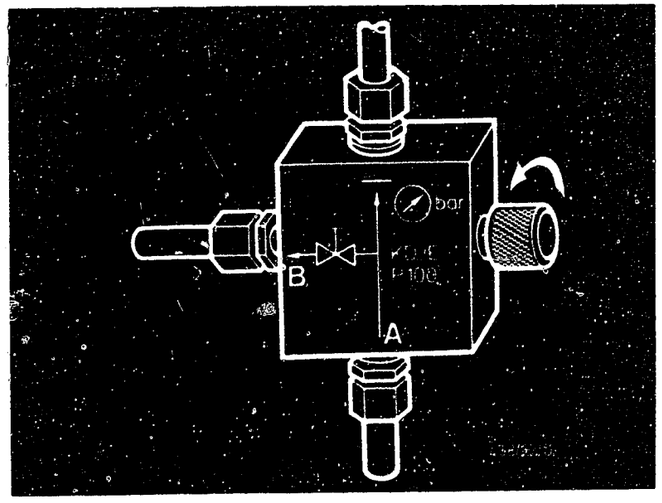
 Set value: see vehicle-specific brief instructions.

* Fuel return line to fuel tank constricted. For test purposes, unscrew return line at pressure regulator for primary pressure and route return flow into separate tank.

* Primary pressure regulator (diaphragm pressure regulator) not O.K.
 Replace pressure regulator.



Continued on next picture page



2.2 "Warm" lower-chamber pressure:

Switch on electric pump by jumping the safety circuit.

Do not switch on ignition, i.e. pressure actuator deenergized.

Close valve screw of directional-control valve (turning clockwise).

The pressure indicated on the pressure gauge must drop below the previously measured primary-pressure value.

Determine set value for "warm" lower-chamber pressure from graph according to the primary pressure measured – see vehicle-specific brief instructions.

Set value obtained?

N>

Possible causes of incorrect measurement result:

* KE restriction (fuel-decoupling restriction in fuel distributor) clogged. To test, measure throughflow:

 Switch off electric fuel pump.

 Unscrew thin fuel line to primary-pressure regulator on fuel distributor (arrow: bottom picture). Connect hose line to free connection with ball connection M 10 x 1. Hold hose line in measuring glass.

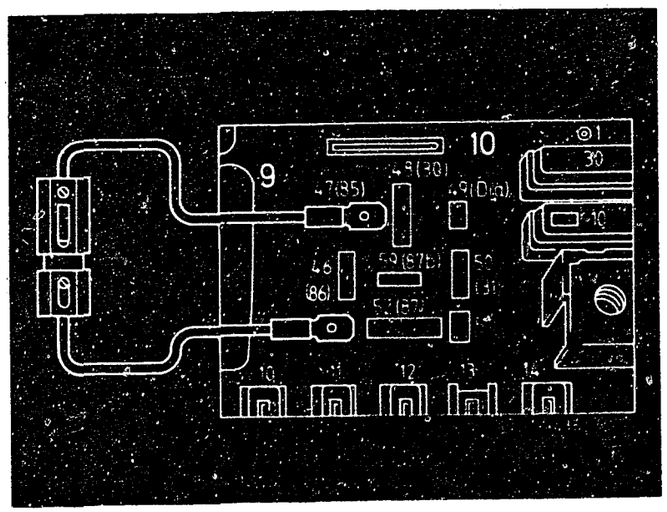
 Again switch on electric fuel pump by jumping the safety circuit and measure the overflow quantity.

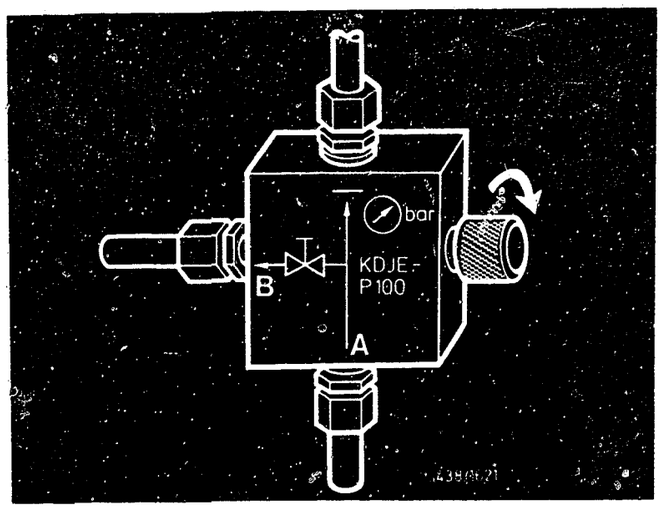
 Set value: see vehicle-specific brief instructions.

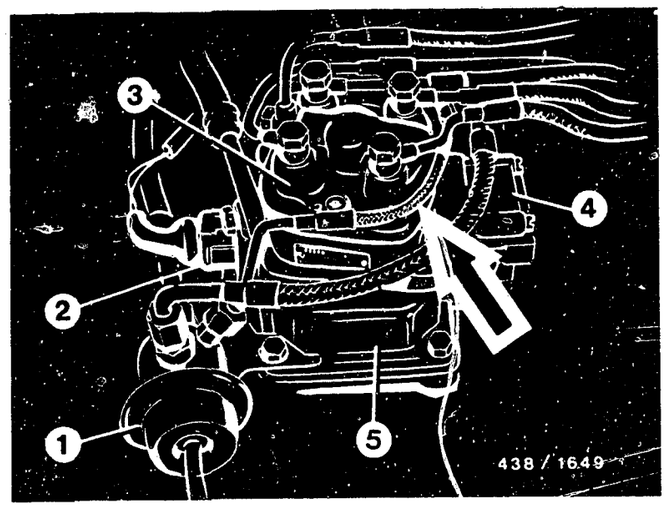
 If the measured value differs from the set value, replace fuel distributor.

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TROUBLE-SHOOTING PROGRAM (6) CONTINUED (6)

* Electrohydraulic pressure actuator defective. Replace pressure actuator:

 Clean the fuel distributor in the area of the pressure actuator and unscrew pressure actuator. Always mount new pressure actuator, with new seal rings and genuine fastening screws (non-magnetic steel).

Continued on next picture page

J01 — ⟺

J02 — ⟺

TROUBLE-SHOOTING PROGRAM (6) CONTINUED (7)

V

2.3 "Cold" lower-chamber pressure:

Switch on electric fuel pump by jumping the safety circuit.

Switch on ignition so that pressure actuator is energized with static current (approx. 100 mA).

Valve screw of directional-control valve remains closed (turn clockwise).

The pressure indicated on the pressure gauge must drop below the previously measured primary pressure.

Determine the set value for "cold" lower-chamber pressure from the graph according to the measured primary pressure and the actuator current (static current) actually indicated by the ammeter - see vehicle-specific brief instructions.

Note the tolerance of +/- 0.15 bar to be added to each curve.

Set value obtained?

N>

If the required lower-chamber pressure set value is exceeded or fallen below, the cause lies with the electrohydraulic pressure actuator.
Replace pressure actuator:

Clean fuel distributor in area of pressure actuator and unscrew pressure actuator.
Always mount new pressure actuator with new seal rings and genuine fastening screws (non-magnetic steel).

Y

V

Return to trouble-shooting chart B03

TESTING OVERALL FUEL SYSTEM FOR INTERNAL LEAKS.

Attach pressure gauge KDJE-P 100 with the aid of the connecting-element sets KDJE-P 100/10 and .../11.

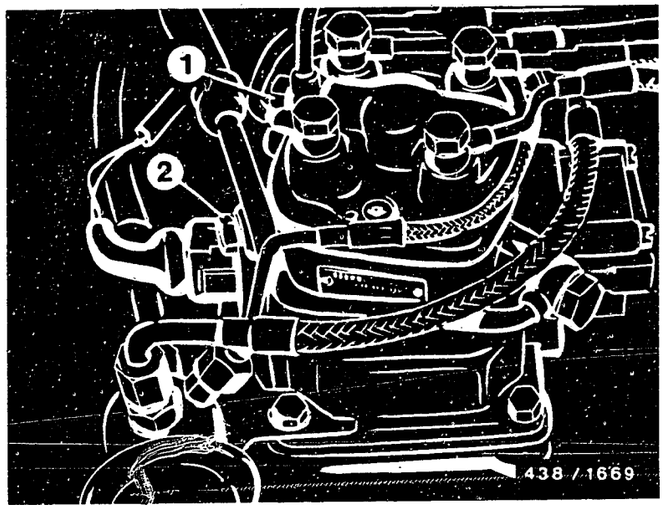
Connect measuring device to start-valve connection at flow distributor and to special test connection in lower part of fuel distributor which is sealed with a screw plug.

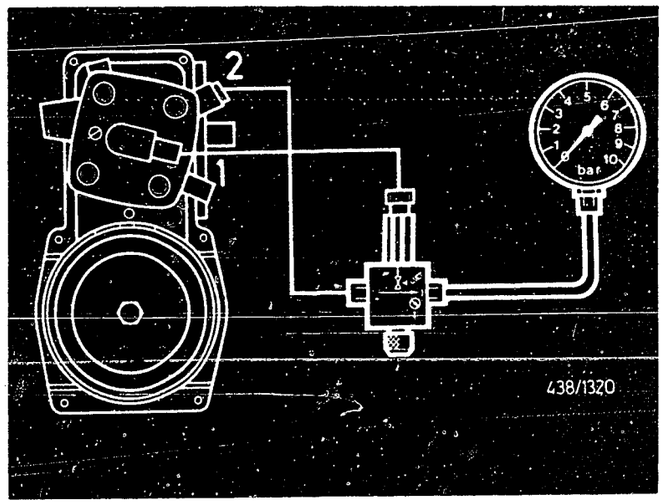
Note: to discharge residual primary pressure, always first detach start-valve connection (1), then lower test connection (2).

Connect port "A" of directional-control valve with double-threaded connector M 8 x 1/M 12 x 1.5 from KDJE-P 100/10 to test connection.

Connect port "B" with hose from KDJE-P 100/11 to start-valve connection of fuel distributor.

Continued on next picture page





TROUBLE-SHOOTING PROGRAM (7) CONTINUED (1)

V

Checking for leaks:

Check with the engine stopped.

Check with engine at normal operating temperature, but not immediately after racing the engine.

Open valve screw of directional-control valve (turning counter-clockwise).

Switch on electric fuel pump by jumping the safety circuit until primary pressure has built up. Then switch off again.

Observe pressure drop on pressure gauge and measure residual pressure after test durations of 10 and 20 minutes.

Set values: see vehicle-specific brief instructions.

Set values obtained?

N>

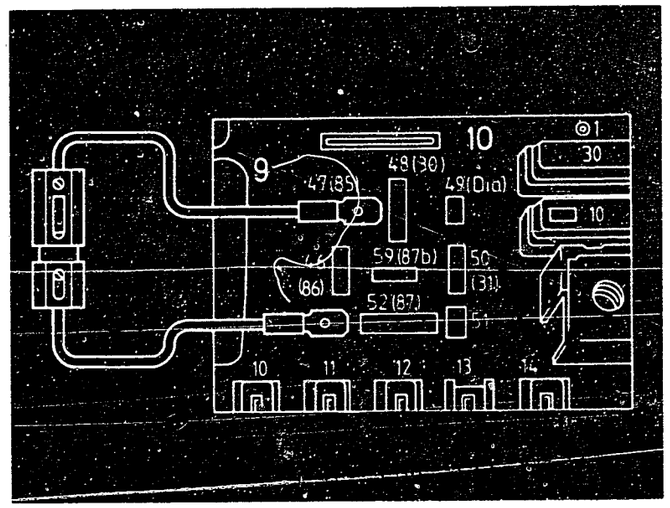
Possible causes of leakage (pressure discharge too fast):

* Primary pressure regulator (diaphragm pressure regulator) leaking.

 For test purposes, unscrew return line at primary pressure regulator and seal it tightly (e.g. with ball and cap nut M 14 x 1.5). Repeat leak test.
 If there is now no leak, replace primary pressure regulator.

* Check valve in threaded connection of electric fuel pump on pressure end leaking.

 For test purposes, pinch off intake line of electric fuel pump (e. g. with pinch-off clamp W 157 from Matra) and repeat leak test.
 If there is now no leak, replace threaded connection:

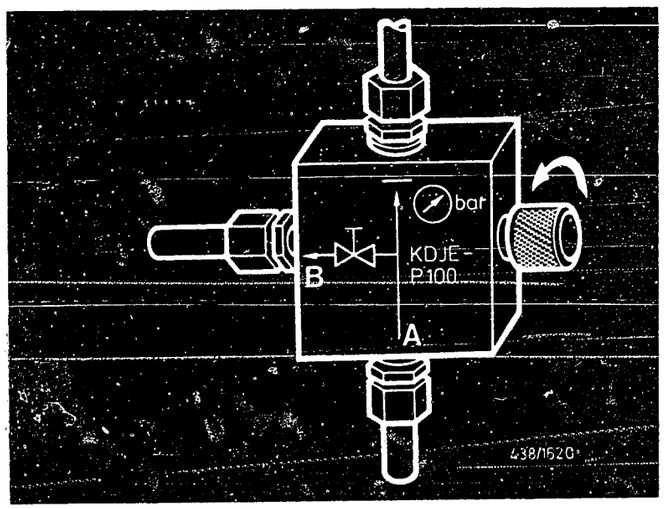


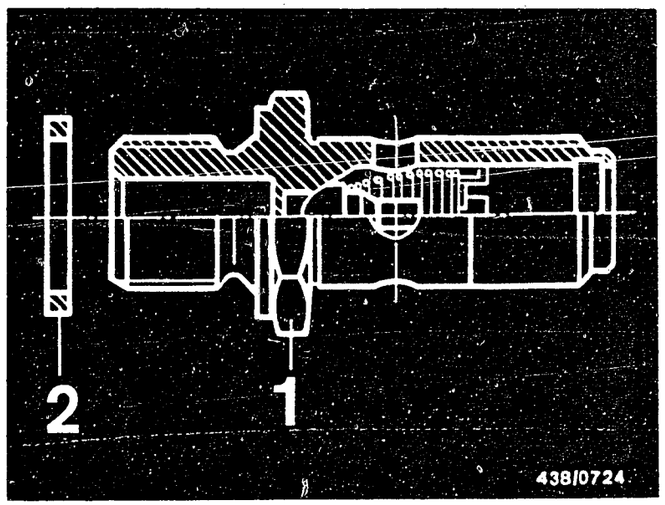
Y

Return to trouble-shooting chart B03

V

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The new threaded connection (1) is supplied with the appropriate special sealing ring (2) as a part set with part number 1 587 010 006.

Pinch intake hose of electric fuel pump off again.
Unscrew cap nut from pressure line whilst counterholding fixed hexagon. Remove pressure line and sealing rings.
Catch residual fuel which runs out. Unscrew threaded connection and replace it with a new one.
Counterhold fixed hexagon in each case.
Tightening torque 10... 16 Nm. Reconnect pressure line with new sealing rings and cap nut.

* Start valve leaking.

For test purposes, remove start valve.
Fuel line remains connected.
Do not kink or damage line.

Continued on next picture page

Switch on electric fuel pump by bridging safety circuit. Clean nozzle of start valve. No droplets may now drip off the nozzle within one minute. The start valve must remain leakproof even when shaken and knocked.

Replace leaky start valve.

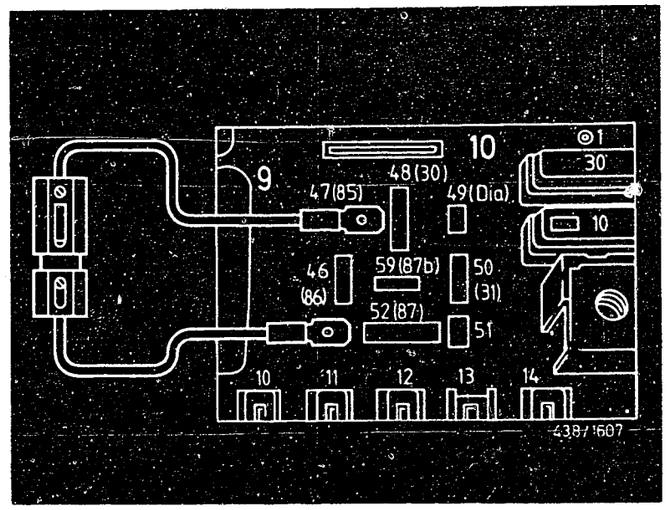
Note: if the start valve had to be replaced on account of a leak, the idle adjustment is to be checked and corrected if necessary (coordinate L23).

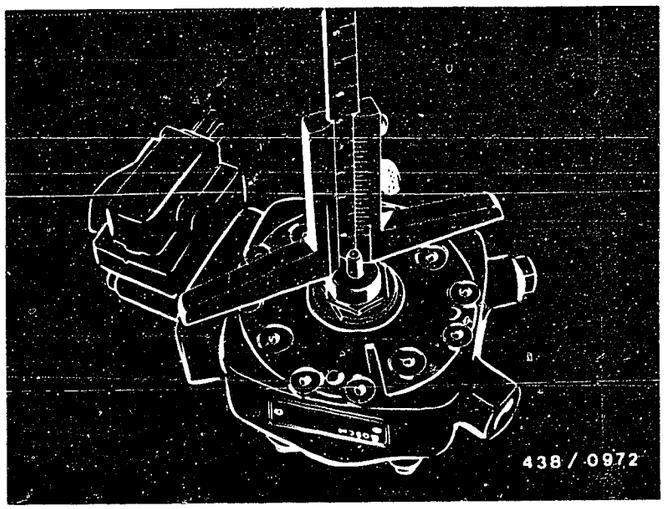
* Sealing ring of lower plunger seal in fuel distributor leaking.

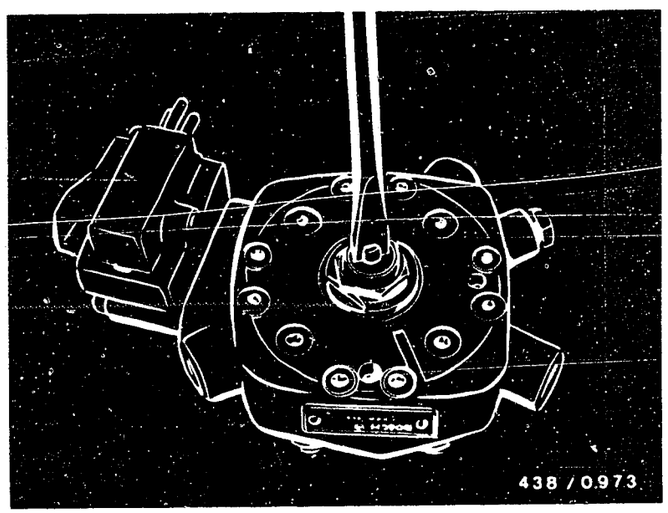
Clean fuel distributor. Unscrew all fuel connections and unscrew fuel distributor from air-flow sensor.

Measure position of slotted nut of plunger seal with respect to hexagon nut and note down value. Also scratch on mark to indicate turning position of slotted nut.

Continued on next picture page







H13 — <⟹>

H14 — <⟹>

H15

TROUBLE-SHOOTING PROGRAM (7) CONTINUED (4)

V

Unscrew slotted nut with pin wrench and carefully replace shaped seal.
Screw in slotted nut as far as position established on removal and turn to scratch mark. Fit fuel distributor with a new sealing ring and tighten fastening screws to 3.2...3.8 Nm.

Finally check idle motion of sensor-plate lever: slightly lift sensor plate.
There must be a perceptible idle motion between zero position and contact point of control plunger. In the center of the sensor plate this must be between "perceptible" and 2 mm. If necessary, disassemble fuel distributor again and correct slotted nut accordingly.
Note: 0.1 mm at the slotted nut produces approx. 0.7 mm in the center of the sensor plate.

V

Return to trouble-shooting chart B03

J13 — <⟹>

J14 — <⟹>

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J15

TROUBLE-SHOOTING PROGRAM (10) CONTINUED (1)

T

TESTING INJECTION VALVES.

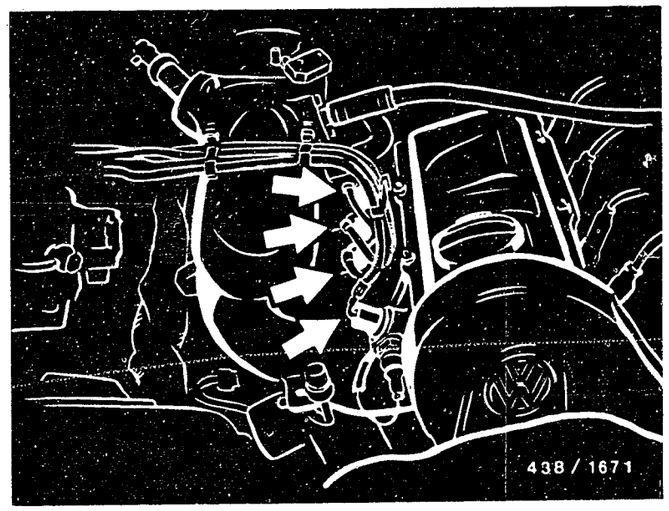
Remove injection valves:

To do so, unscrew fuel-injection tubing, remove both twin holders and pull injection valves out of mounting holes (arrows).

Do not kink or damage fuel-injection tubing.

Note: the following test specification refers to the valve testers KDJE-P 400 (previously KDEP 7452) and 0 681 200 700.

Pay attention to test-equipment specification!



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1. Check for coarse dirt:

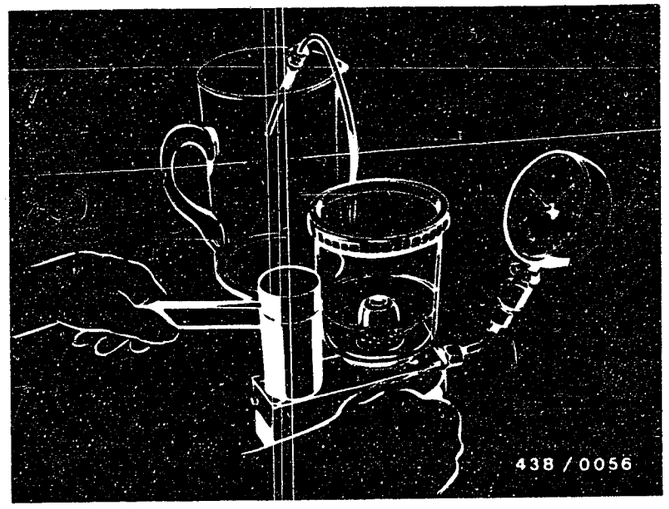
Connect injection valve to valve tester and bleed delivery line with union nut open with several actuations of the lever. Tighten union nut.

With pressure-gauge shutoff valve open, slowly actuate hand lever (approx. 2 sec./ stroke). Pressure must build up to min. 1...1.5 bar gauge pressure.

Pressure buildup obtained?

N>

If there is no pressure buildup, the injection valve is leaking badly (e.g. jammed-in dirt particle).
An attempt can be made by several vigorous actuations of the lever to purge the valve.
If this is possible, continue testing. If purging is not possible, discard the injection valve.



2. Checking the opening pressure:

With shutoff valve closed, purge and bleed valve through several actuations of the lever.

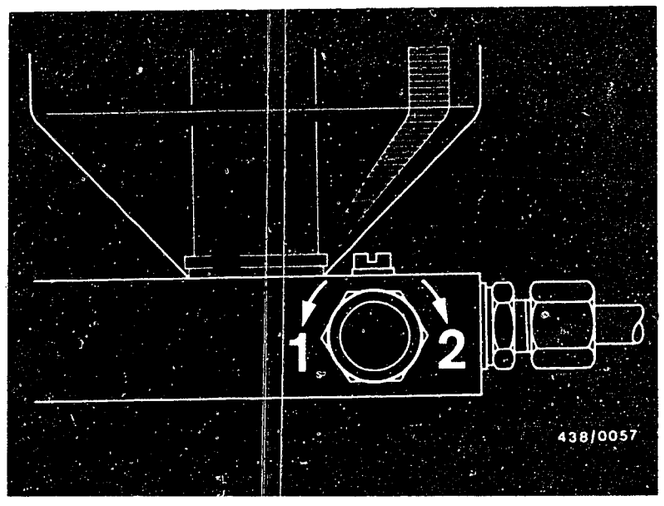
Open shutoff valve and check opening pressure while actuating the lever slowly (approx. 2 sec./stroke).

Set value: see vehicle-specific brief instructions.

Set value obtained?

If opening pressure not within tolerance, discard injection valve.

It is also possible to replace indivudual injection valves within in a set.



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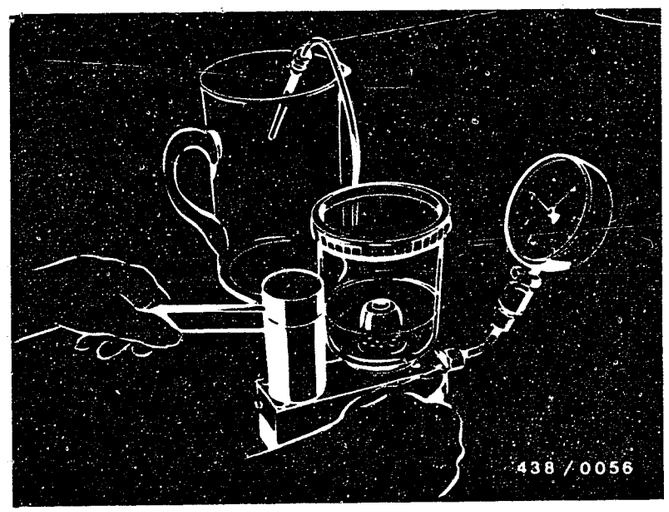
TROUBLE-SHOOTING PROGRAM (8) CONTINUED (2)

3. Leak test:

Open shutoff valve and slowly raise pressure to 0.5 bar below the measured opening pressure and hold at this level. Within 25 seconds, no drop may form at the valve.

O.K.?

N> Discard injection valve if leaking.



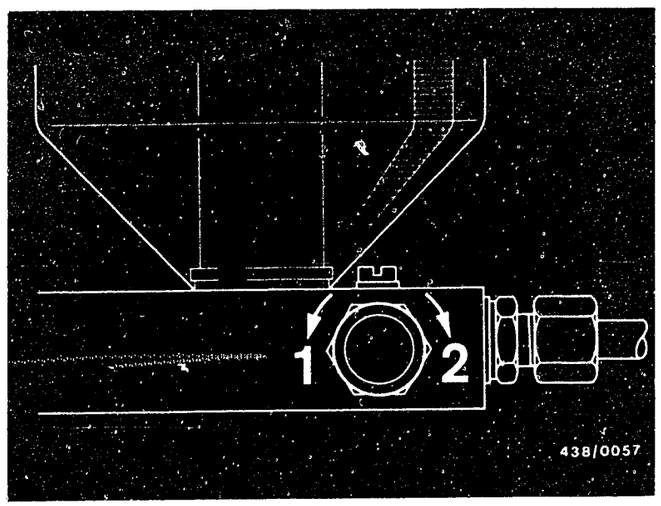
4. Chatter test, chatter behavior, spray formation:

Shut-off valve closed. Lever speed approx. 1/s. The valve must chatter audibly. No drops may form at the valve orifice. There must be no cord spray. One-sided, atomized spray formation within an overall spray angle of approx. 35° is permitted.

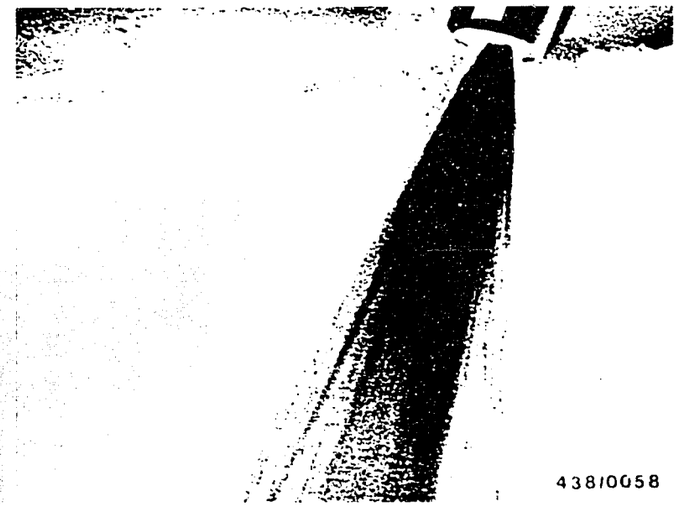
Refer to following pictorial examples for aid to assessment.

Injection valves O.K.?

N> Discard injection valve if defective.



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43810058

Good spray formation –
injection valve O.K.

One–sided, but good spray
formation –
injection valve O.K.



43810059

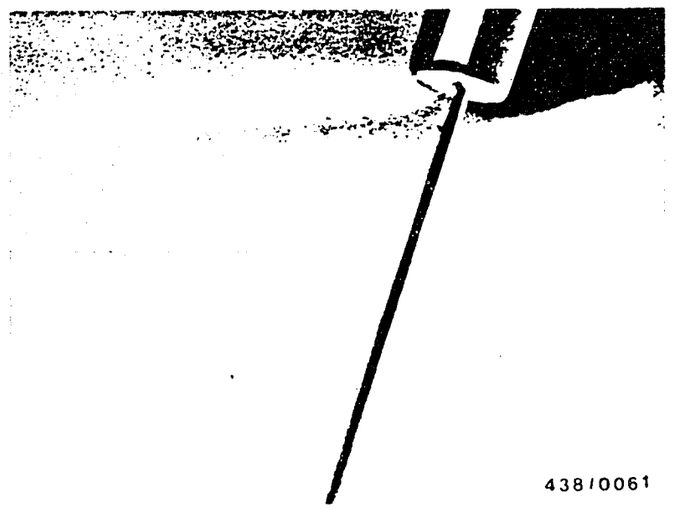
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438/0060

Poor spray formation
(formation of drops)
Discard injection valve

Poor spray formation
(cord spray)
Discard injection valve



438/0061

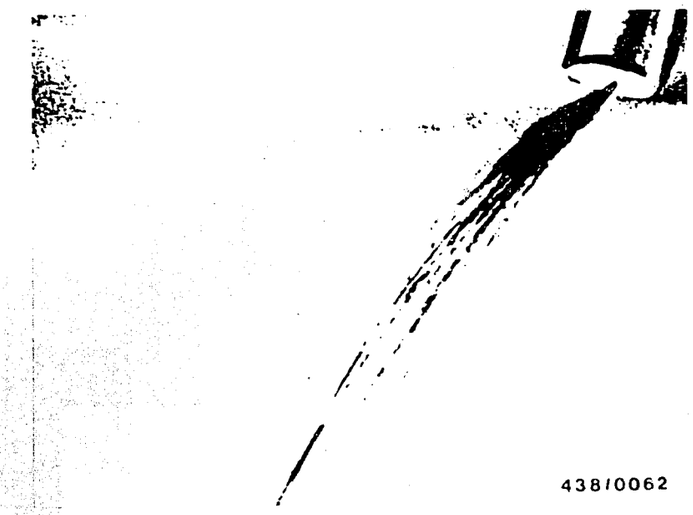
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TROUBLE-SHOOTING PROGRAM (8) CONTINUED (5)

Install injection valves again – always use new sealing rings. Fit both holders. Connect fuel-injection tubing to injection valves. Ensure that fuel-injection tubing is laid such that there is neither tension nor kinking.

Note:
If one or more injection valves has/have to be replaced, the idle adjustment is to be checked and if necessary corrected as a final step.

Return to trouble-shooting chart B03



438/0062

Poor spray formation (spray in strands)
Discard injection valve

J25 — ⟺

J26 — ⟺

TROUBLE-SHOOTING PROGRAM (9)

V

FUEL DISTRIBUTOR – FUEL-DELIVERY COMPARISON MEASUREMENT.

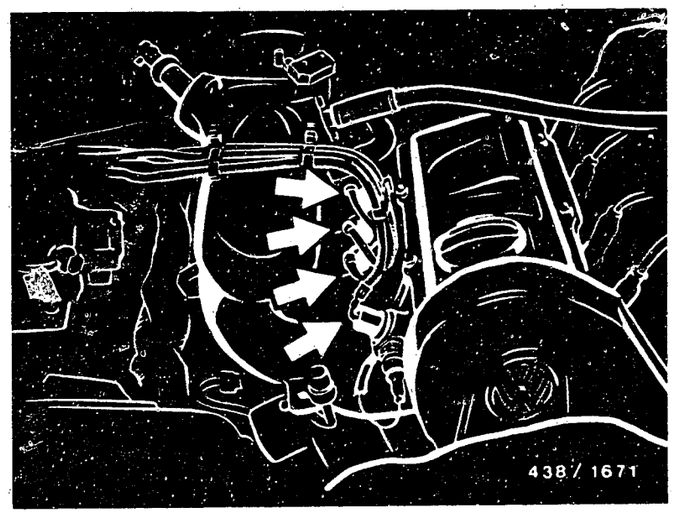
1. Preparation:

Measurement is to be performed with measuring instrument for comparing fuel delivery KDJE-P 200 (previously KDEP 7451). Accessories required: adapter leads KDJE-P 200/25 and adapter sleeves KDJE-P 200/19.

Testing is performed with the original engine injection valves. It is thus possible to test whether any scatter is being produced by the fuel distributor or by the injection valves.

Remove injection valves for testing. To do so, unscrew fuel-injection tubing, remove both twin holders and pull injection valves out of mounting holes (arrows).

Do not kink or damage fuel-injection tubing.



Y

Y

Continued on next picture page

2. Setting up, connection of tester for delivered quantity comparison:

Set up tester next to vehicle (e.g. on tester trolley KDJE-W 100) and align with integral spirit level.

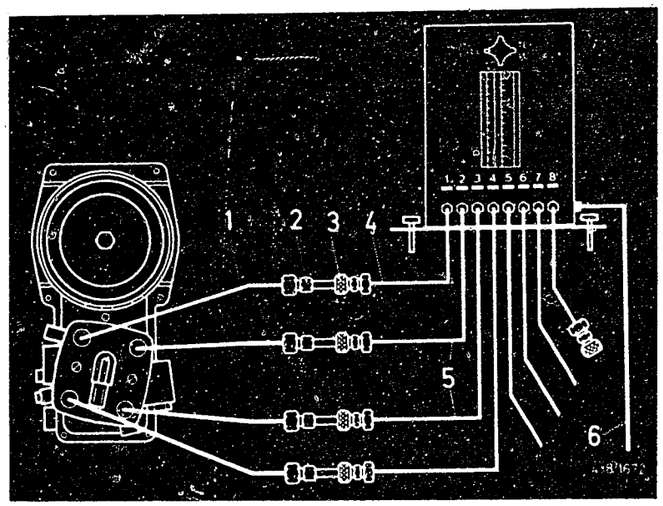
Connect adapter lines KDJE-P 200/25 to the delivery connections of a fuel distributor. The original start valve remains connected.

Connect injection valves to the adapter lines and, using adapter sleeves KDJE-P 200/19, insert as far as they will go into the automatic connectors of the tester lines. Tighten knurled nuts firmly.

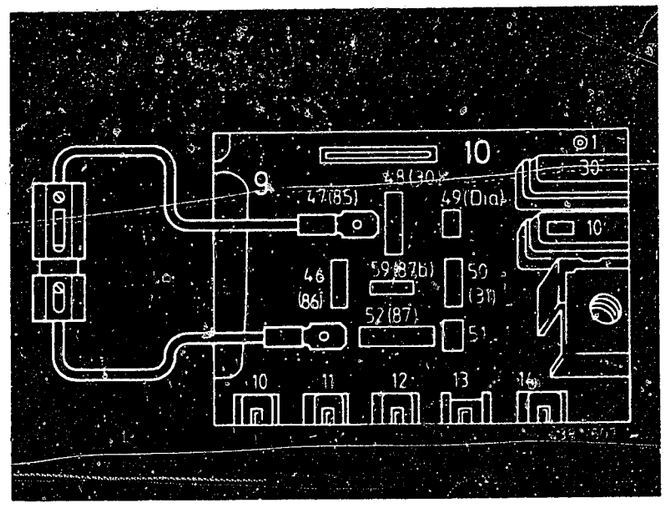
Bleeding the tester:

Switch on electric fuel pump by jumping the safety circuit. Raise air-flow sensor plate as far as it will go. Press buttons of 8-way valve one after the other, switching over 3-way change-over valve repeatedly until both measuring tubes are free of air.

Continued on next picture page



1 = Adapter lines DJE-P 200/25
2 = Injection valves
3 = Adapter sleeves KDJE-P 200/19
4 = Automatic connector
5 = Tester lines
6 = Return lines to fuel-tank filler neck

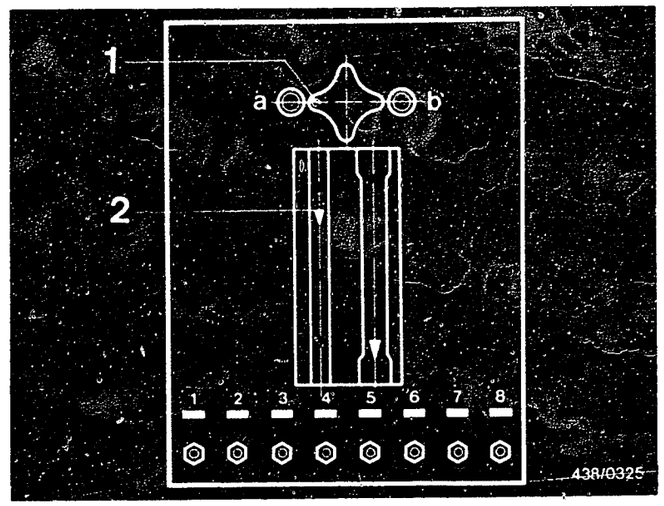


3. Instructions on testing:

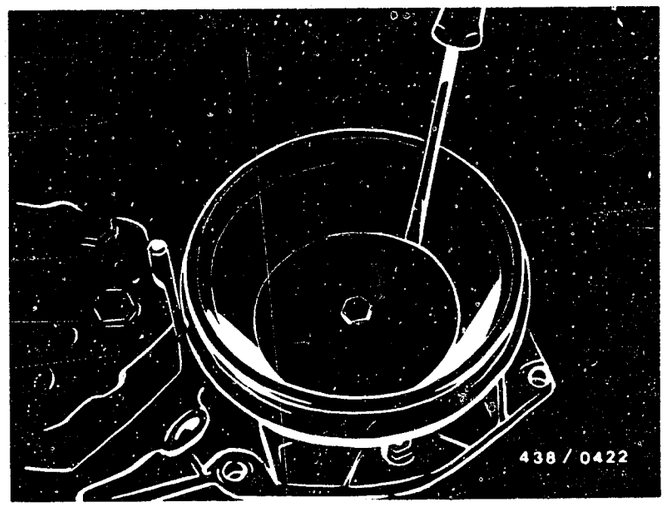
Delivered-quantity comparison is performed in the idle, part-load and full-load ranges. Idle measurement with the small measuring tube (white dot on knob to left); part-load and full-load measurements with the large measuring tube (white dot on right).
For each measurement, be sure to wait until the float has reached its final position. This may take 20...30 seconds in the case of small deliveries.

Precise adjusting and fixing of the air-flow sensor plate for the various load ranges with a screwdriver (small screwdriver for idle position) which is jammed to the appropriate depth between air funnel and sensor plate.

Continued on next picture page



1 = White dot
2 = Measuring line
a = Idle
b = Part load/full load



4. Testing:

Switch on electric fuel pump by jumping the safety circuit.

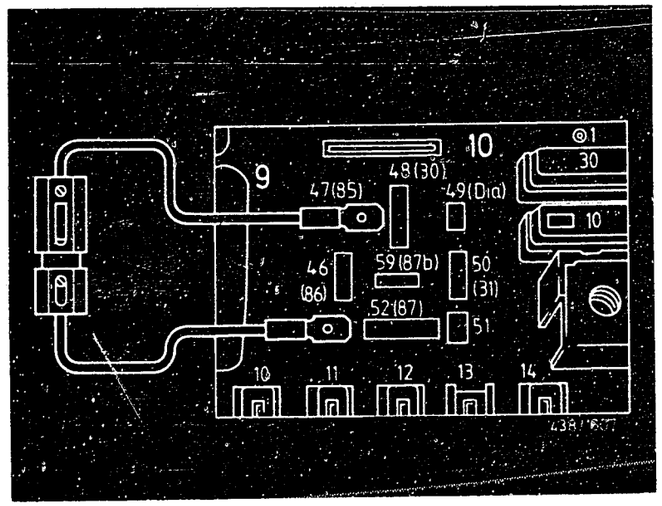
Disconnect plug from lambda sensor (take apart) (arrow in center picture).

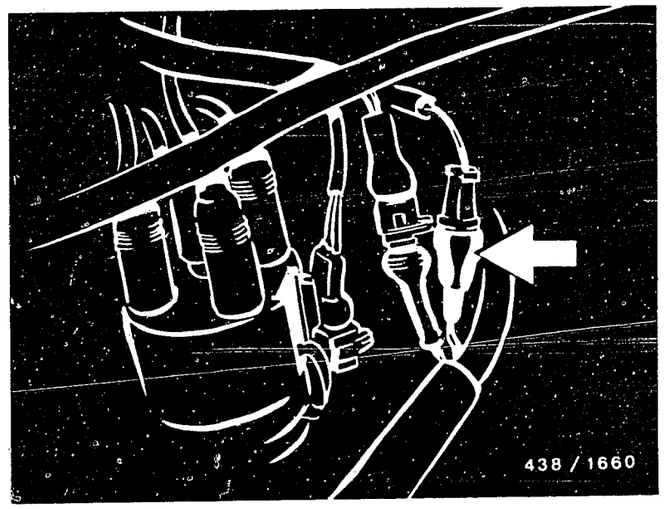
Set values: see vehicle-specific brief instructions.

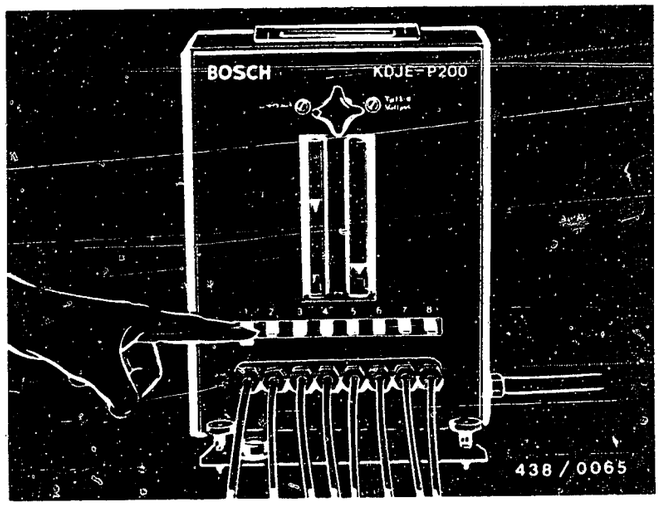
The value "setting point" in the test specifications refers always to the fuel-distributor outlet with the smallest delivery, i.e. establish this outlet first of all:

Press button for outlet 1. Deflect air-flow sensor plate until the appropriate measuring tube shows approx-imately the value "setting point". Check the remaining outlets and establish the outlet with the smallest delivery. Press the button of this outlet again and set delivery precisely to "setting point" by adjusting the position of the sensor plate. One after the other, press the remaining buttons and measure maximum delivery from each outlet (deviations may lie only above the "setting point").

Continued on next picture page







TROUBLE-SHOOTING PROGRAM (9) CONTINUED (4)

Perform test in all three load ranges as per set values.

Set values obtained?

N>

If two great a deviation is found in one of the three load ranges, repeat test as a check. If the result is confirmed, check whether the cause lies in the fuel distributor or in the injection valves.

To do this, swap round the injection valves with the largest and smallest deviations. If the result remains the same, the cause is in the fuel distributor. If the fault follows the injection valves, the cause lies with the injection valves.

Replace defective fuel distributor or replace defective injection valves.

Continued on next picture page

K07 — <==>

K08 — <==>

TROUBLE-SHOOTING PROGRAM (9) CONTINUED (5)

5. Checking the minimum delivery from all outlets:

Fully deflect air-flow sensor plate and check delivery from all outlets.

Set value: see vehicle-specific brief instructions.

Is minimum delivery obtained at all outlets?

N>

Replace fuel distributor.

Concluding work:

Re-install injection valves - always with new sealing rings. Fit both holders. Connect fuel-injection tubing to valves. Ensure that fuel-injection tubing is laid such that there is no tension and no kinking.

Re-connect all leads. Fit relay of safety circuit. Check by means of engine trial run whether all connections are leakproof.

Finally check idle adjustment and correct if necessary (coordinate L23).

Y

Return to trouble-shooting chart B03

K09 — <⟹>

K10 — <⟹>

TROUBLE-SHOOTING PROGRAM (10)

TESTING ADJUSTMENT AND FUNCTION OF THROTTLE VALVE:

The adjusting screw (arrow) for the basic throttle-valve setting was precisely set at the factory and secured with locking compound. Under normal circumstances this setting is not to be altered.

A visual inspection is to be performed to establish whether the locking compound has been removed, whether traces of work having been performed indicate previous manipulation of the throttle-valve assembly, or whether re-adjustment may be necessary as a result of wear.

O.K.?

N>

In the event of uncertainty the basic setting of the throttle valve can be readjusted:

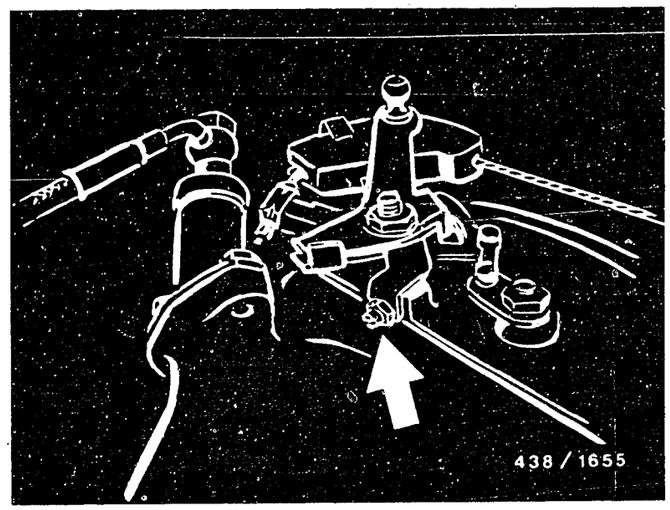
* Turn back adjusting screw (arrow) until there is a gap between the screw and the stop.

* Screw in adjusting screw until it just contacts the stop.

 Note: to facilitate work, hold a thin piece of paper between adjusting screw and stop. Determine contact point by constantly moving the paper and at the same time screwing in the screw.

* As of point of contact, screw in the adjusting screw precisely half a turn further and lock.

 Secure adjusting screw with locking compound.



Continued on next picture page

TROUBLE-SHOOTING PROGRAM (10) CONTINUED (1)

Remove air scoop, air-flow sensor - throttle-valve assembly.

Perform a visual inspection to establish whether above throttle valves are fully open when the control lever is actuated as far as the full-load stop.

Then depress accelerator pedal as far as it will go. The control lever must be moved as far as the full-load stop.

N>

If necessary, adjust full-load stop or accelerator cable such that both throttle valves are fully open with maximum acceleration.

Return to trouble-shooting chart B03

K13 — <==>

K14 — <==>

TESTING
CONTROL-UNIT FUNCTIONS:

Test prerequisites:

* Previous elimination of all faults detected by self-diagnosis and stored.

* The pressure actuator, temperature sensor (engine), throttle-valve switch (idle and full load) and their leads must be O.K.

* Engine at operating temperature.

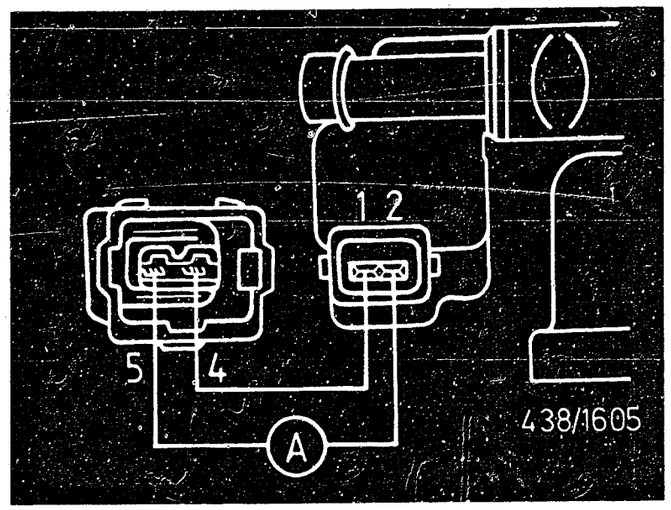
* Disconnect lambda-sensor connector.

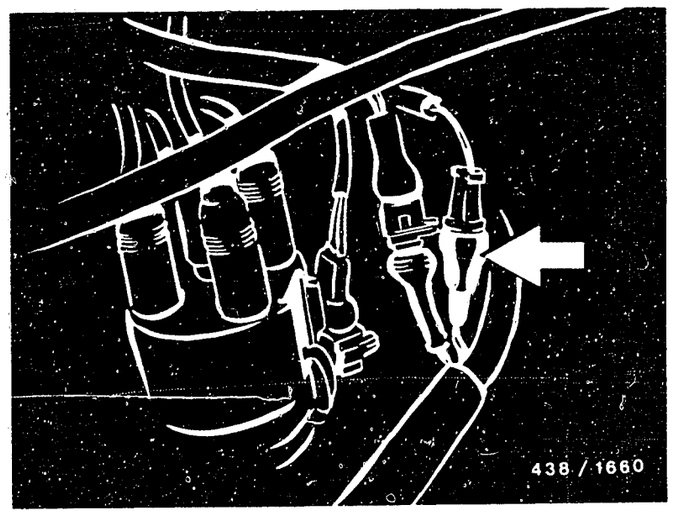
Connect ammeter to pressure actuator:

Detach connector at pressure actuator. Reconnect lead from term. 1 at pressure actuator using test lead. Connect ammeter at term. 2 between pressure actuator and connector. Make connections with test leads KDZS 0004 and KDUM 0008.

Test following enrichment functions:

Continued on next picture page





TROUBLE-SHOOTING PROGRAM (11) CONTINUED (1)

* No-load current:

Switch on ignition, do not actuate starter.

Ammeter indicates no-load current.

Set value: see vehicle-specific brief instructions.

Note:
No-load current is maintained until - following switch-on of the ignition - a certain cranking speed (approx. 30 min^{-1}) is thus exceeded as a result of the engine being switched on.

N> Control unit defective.

Replace control unit.

Y

* Starting enrichment:

To prevent engine starting up and fuel being injected: remove fuse 13, detach connector of power output stage at ignition coil.

Actuate starter and take current reading. Starting current is indicated for max. 3 s and then rapidly regulated.

Set value: see vehicle-specific brief instructions.

Is set value attained?

N> Control unit defective.

Replace control unit.

Y

Continued on next picture page

TROUBLE-SHOOTING PROGRAM (11) CONTINUED (2)

V

* Post-start enrichment:

Applies to all following current measurements:

Detach connector at temperature sensor (engine).
Connect resistor or resistance decade 2,5 k Ω to both terminals of connector (corresponds to engine temperature + 20°C).

Fit fuse 13 again and re-connect connector at power output stage.

Start engine and take current reading. The current value remains constant for several seconds and is then slowly regulated to the "warm-up" value.

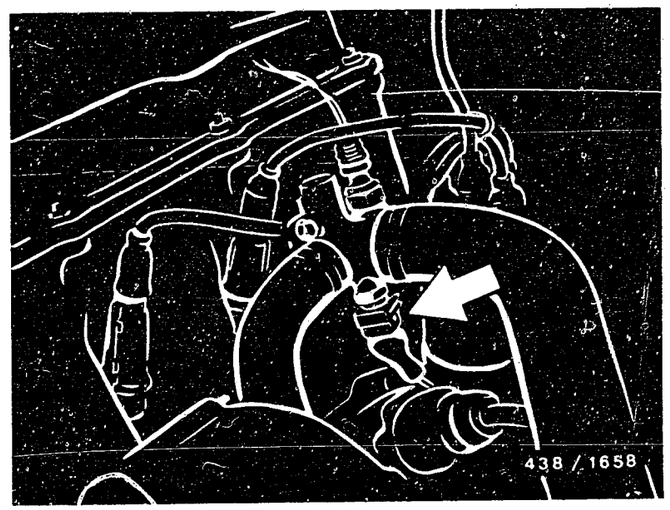
Post-start set value:
see vehicle-specific brief instructions.

Is set value attained?

N>

Control unit defective.

Replace control unit.



Y

Continued on next picture page

TROUBLE-SHOOTING PROGRAM (11) CONTINUED (3)

* Warm-up enrichment:

Run engine at idle and take reading when a constant current has been attained following regulation of the post-start enrichment.

Set value: see vehicle-specific brief instructions.

Is set value attained?

N>

Control unit defective.

Replace control unit.

Y

* Acceleration enrichment:

Suddenly accelerate engine from idle and observe current reading.

Set value: see vehicle-specific brief instructions.

Is set value attained?

N>

Control unit defective.

Replace control unit.

Y

Continued on next picture page

K21 — <==>

K22 — <==>

TROUBLE-SHOOTING PROGRAM (11) CONTINUED (4)

* Full-load enrichment:

Remove resistor at connector of temperature sensor again and connect connector.

Fully depress accelerator pedal for a brief period and take current reading.

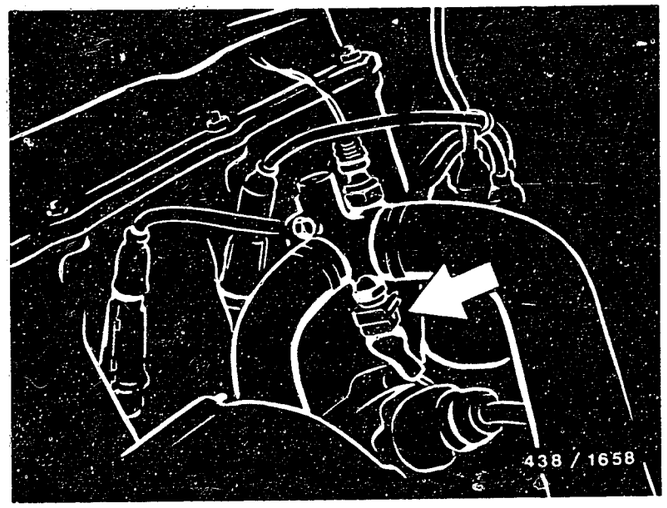
Set value: see vehicle-specific brief instructions.

Is set value attained?

N>

Control unit defective.

Replace control unit.



Y

* Overrun cutoff:

Let engine run and raise engine speed to 3000 min^{-1}. Then suddenly bring throttle valve into idle position and make reading.

Set value: see vehicle-specific brief instructions.

Set value obtained?

N>

Control unit defective.

Replace control unit.

Y

Return to trouble-shooting chart B03

K23 — <==>

K24 — <==>

TROUBLE-SHOOTING PROGRAM (12)

Check tank-ventilation system.

Check visually whether hoses of tank-ventilation system are correctly attached, not bent or damaged.
Check whether hose connections at intake manifold, tank bleeder valve, active-carbon canister and fuel tank are leak-tight.

Are all hoses and connections O.K.?

N> Replace defective hoses as necessary.
Eliminate leakages by tightening hose clamps.

Y

Continued on next picture page

K25 — <⟹>

K26 — <⟹>

TROUBLE-SHOOTING PROGRAM (12) CONTINUED (1)

Check function of tank ventilation valve (ACF frequency valve, with active-carbon canister):

Test actuation signal for ACF frequency valve with oscilloscope. To do so, connect two-pin test lead 1 684 463 093 between frequency valve and its connector.

Connect motortester (special input) to test lead:
red pickup to one of the test-lead connections, black pickup to engine ground.

Note: the free terminal of the lead must not come into contact with ground.

Start warm engine and let it idle.

If correctly connected the oscilloscope shows pulses corresponding to the adjacent picture (top).

Set value: pulses

Pulses present?

N>

tes

Switch off engine and remove both control-unit connector and frequency valve.

* Use ohmmeter to perform continuity test on lead from control unit, terminal 15 to connector of frequency valve, terminal 2.

 Set value: 0 Ω

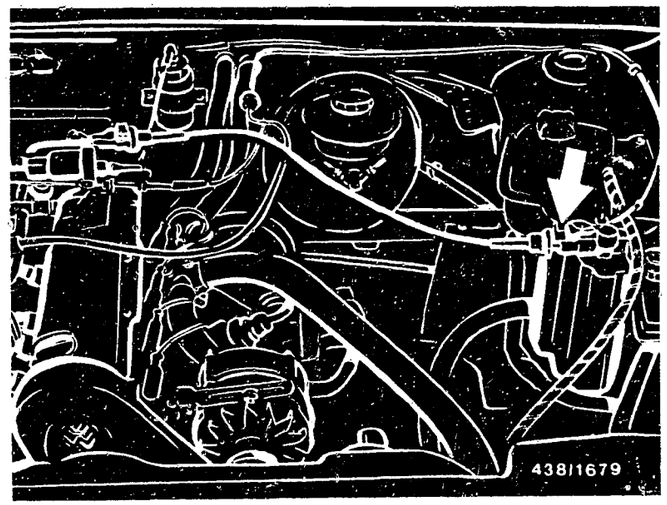
 Eliminate any open-circuit.

* Switch on ignition and use voltmeter to test power supply at connector of frequency valve, terminal 1.

 Set value: battery voltage.

 Eliminate any interruption in power supply from ignition lock via fuse 24 to frequency valve.

 If no fault in lead:
 control unit defective,
 renew control unit.



Continued on next picture page

TROUBLE-SHOOTING PROGRAM (2) CONTINUED (2)

Switch off engine and detach connector at ACF frequency valve.

Use ohmmeter to measure internal resistance of valve directly at both contacts.

Set value: see vehicle-specific brief instructions.

O.K.?

N> Internal resistance outside tolerance: ACF frequency valve defective. Replace valve.

Y

Test mechanical switching function of ACF frequency valve:

Connect term. 1 of connector with test leads KDZS 0004 and KDUM 0008 to corresponding contact of valve. Connect further test lead KDZS 0004 to second valve contact.

Switch on ignition and briefly hold test lead against engine ground several times.
The valve must switch both audibly and perceptibly.

O.K.?

N> Replace sticking or difficult-to-move ACF frequency valve.

Y

Continued on next picture page

TROUBLE-SHOOTING PROGRAM (12) CONTINUED (3)

V

Check function of switching valve for tank ventilation (on intake manifold):

Note: the switching valve is closed when the engine is off and open when it is running.

Pull off connector at switching valve.

Perform voltage measurement at both contacts of connector.

Set values:

* ignition on: battery voltage

* ignition off: 0 V

O.K.?

N>

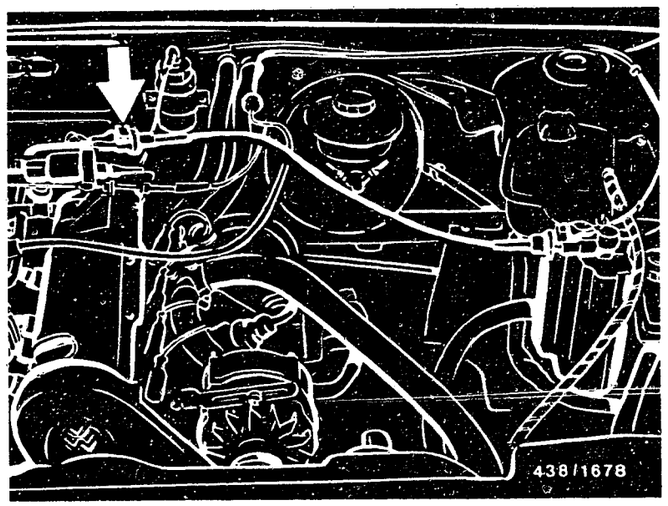
No voltage reading with ignition switched on:

Check fuse 24 for engine timing.

Use ohmmeter to perform continuity test on leads from connector to ignition switch, terminal 15 and from connector to ground point (intake manifold).

Set values: approx. 0 Ω in each case

Eliminate open-circuit.



Y

V

Continued on next picture page

TROUBLE-SHOOTING PROGRAM (12) CONTINUED (4)

Perform resistance measurement directly at the two plug pins of the switching valve.

Set value: see vehicle-specific brief instructions.

O.K.?

N> Replace defective switching valve.

Remove switching valve and blow compressed air through it.

Set value: the valve must be completely leakproof.

O.K.?

N> Replace leaking switching valve.

Continued on next picture page

TROUBLE-SHOOTING PROGRAM (12) CONTINUED (5)

TESTING IGNITION — HIGH-TENSION SIDE.

Check condition (e.g. open-circuit, shunts) of spark plugs, spark-plug connectors, interference-suppression resistors, high-tension ignition cables, distributor cap, distributor rotor etc..

Assess for example by way of ignition oscillogram, resistance measurements, visual inspection.

High-tension side O.K.?

N> Repair high-tension side, renew damaged parts.

Y

Return to trouble-shooting chart B03

L07 — <⟹>

L08 — <⟹>

TROUBLE-SHOOTING PROGRAM (13)

V

TESTING IGNITION COIL:

* Visual inspection:
 Remove protective cap from ignition coil and check whether plug is present and whether any potting compound has emerged (see picture, item 1).

* Electrical testing:

 Resistance measurements at following terminals:

 Primary: term. 15 and term. 1.

 Secondary: term. 1 and term. 4.

 Set values: see vehicle-specific brief instructions.

Visual inspection O.K.?
Are set values attained?

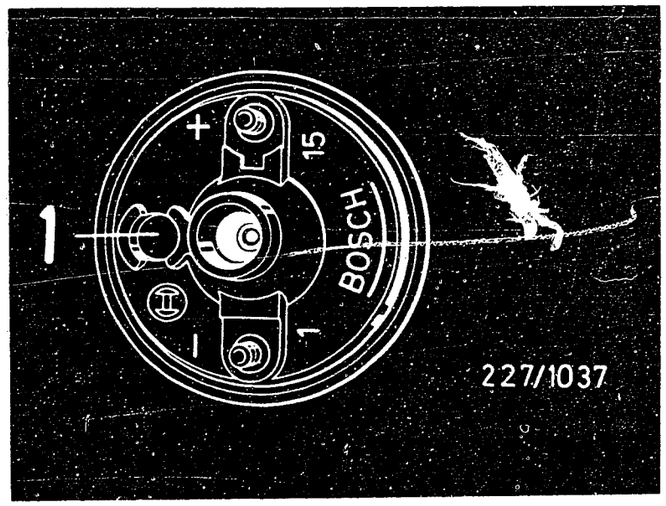
N>

* No plug or potting compound emerged:

 Replace control unit, power output stage (trigger box) and ignition coil.

* Resistance values not within tolerance:

 Replace ignition coil.



Y

V

Return to trouble-shooting chart B03

TROUBLE-SHOOTING PROGRAM (14)

V

TESTING IGNITION FUNCTION - CONTROL UNIT.

Control-unit connector, trigger box (power output stage) and ignition distributor connected.

Push back rubber sleeve at connector of trigger box.

In accordance with operating instructions, connect oscilloscope in program switch setting "special" to trigger-box connector, term. 2 (signal output).

Example MOT 201:
red terminal with test prod to signal output, black terminal to vehicle ground:

Start engine and allow it to idle; or if engine does not start, actuate starter.

Oscilloscope must show rectangular pulse.

Rectangular pulse present?

N>

Detach control-unit connector, trigger box and ignition coil.

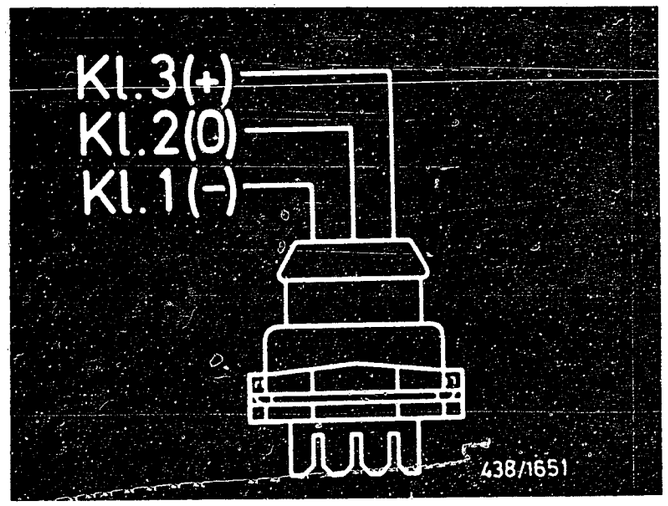
Use ohmmeter to check following leads for continuity:

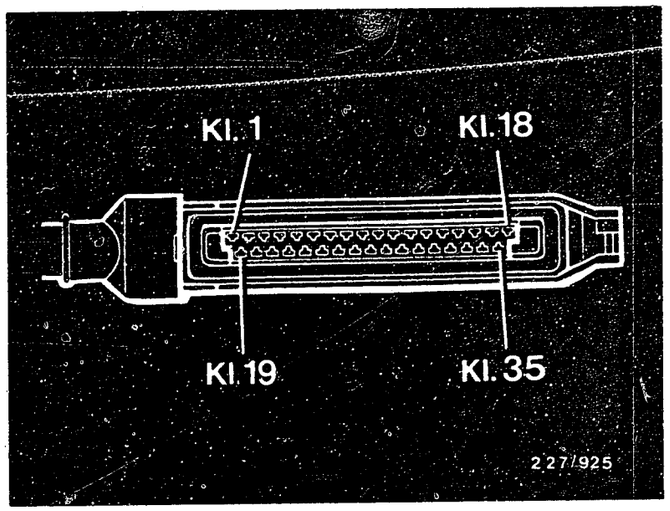
Ignition distributor connector (top picture)	Control unit connector (center picture)
Term. 2	Term. 30

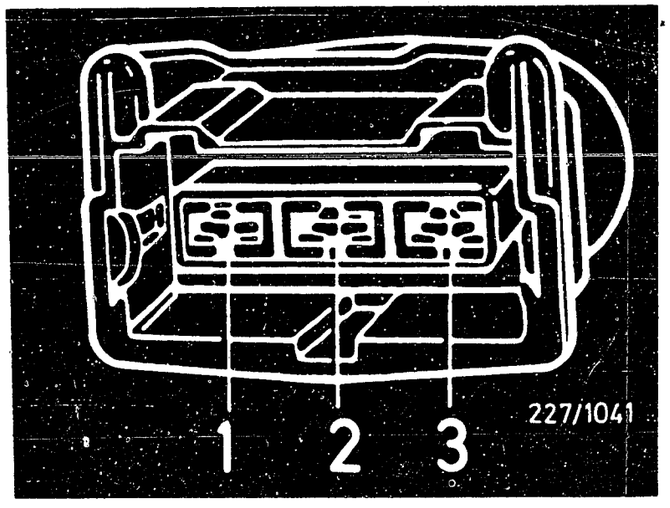
Trigger box connector (bottom picture)	Control unit connector (center picture)
Term. 2	Term. 11

Set values: approx.0 Ω in each case
Eliminate any open-circuit.

If there was no fault in the lead: control unit defective.
Replace control unit.







Y

Return to trouble-shooting chart B03

TROUBLE-SHOOTING PROGRAM (15)

TESTING VOLTAGE SUPPLY, TRIGGER BOX (POWER OUTPUT STAGE, IGNITION COIL).

With ignition switched off, detach connector at trigger box. Perform voltage measurement at connector, term. 1 (+) and term. 3 (–).

Switch on ignition.

Set value: battery voltage.

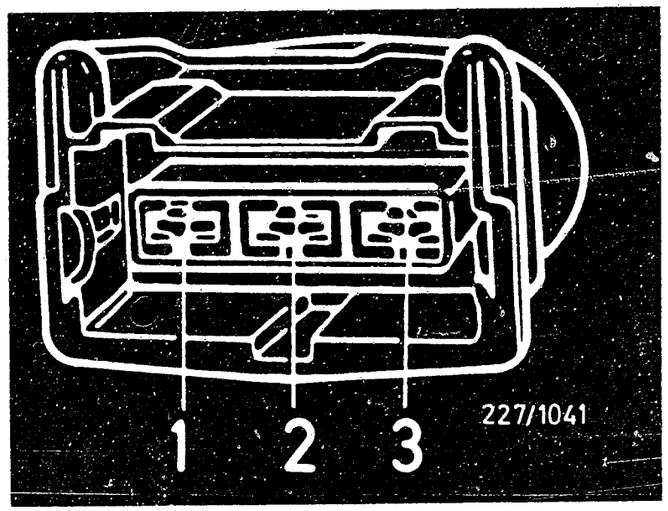
Is set value attained?

N>

Use ohmmeter to perform test for open-circuit/contact resistance on leads from ignition switch, term. 15 to trigger-box connector, term. 1 and from connector, term. 3 to engine ground (ground point – intake manifold).

Set values: approx. 0 Ω

Eliminate any open-circuit or contact resistance.



Y

Return to trouble-shooting chart B03

L13 — ⟺

L14 — ⟺

TROUBLE-SHOOTING PROGRAM (16)

V

TESTING IGNITION COIL, PRIMARY SIGNAL.

Test with oscilloscope or engine-speed tester.

Remove protective cap from ignition coil.

Connect oscilloscope in accordance with operating instructions to ignition coil.
Example MOT 201:
yellow clip to term. 15,
green clip to term. 1.

Start engine. Oscilloscope must show primary voltage (regardless of magnitude).

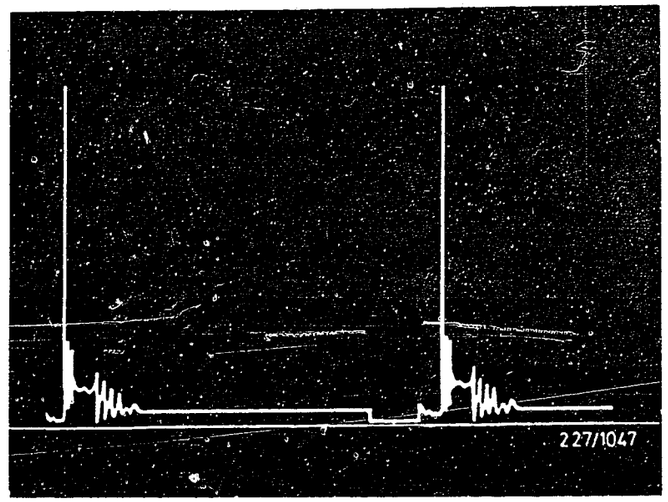
OR

Connect engine-speed tester in accordance with operating instructions to ignition coil.

Start engine. Engine-speed tester must indicate a value (regardless of magnitude).

Primary signal present?

N> Renew ignition coil complete with trigger box.



Y

V

Return to trouble-shooting chart B03

TROUBLE-SHOOTING PROGRAM (17)

V

TESTING VOLTAGE SUPPLY,
IGNITION COIL UNDER LOAD.

Connect voltmeter to ignition coil, term. 15 and engine ground.

Start engine and run at idle.

Set value: min. 10 V.

Is set value attained?

N>

Disconnect + lead from battery.

Check for contact resistance over entire wiring from battery + via ignition switch and trigger-box connector, term. 1 to ignition coil, term. 15.

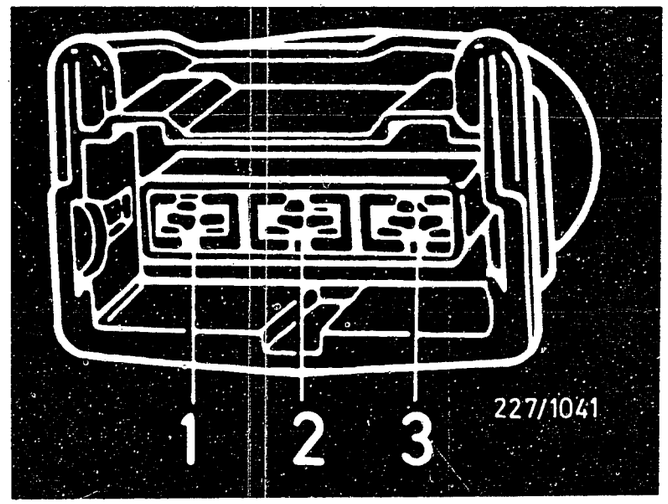
Set value for total resistance: max. 0.5 Ω

Eliminate contact resistance.

Y

V

Return to trouble-shooting chart B03



TROUBLE-SHOOTING PROGRAM (18)

V

TESTING IGNITION DISTRIBUTOR - INSTALLED SETTING.

* Set crankshaft to TDC - cylinder 1 (top picture, arrow).

* At the same time, mark on camshaft gear must be in alignment with top edge of valve cover gasket (center picture, arrow).

* Remove cap, distributor rotor and protective dust cover of ignition distributor. Attach distributor rotor again.

* The distributor rotor must now be located such that the center of the distributor-rotor electrode faces the housing mark for cylinder 1 (bottom picture, arrow).

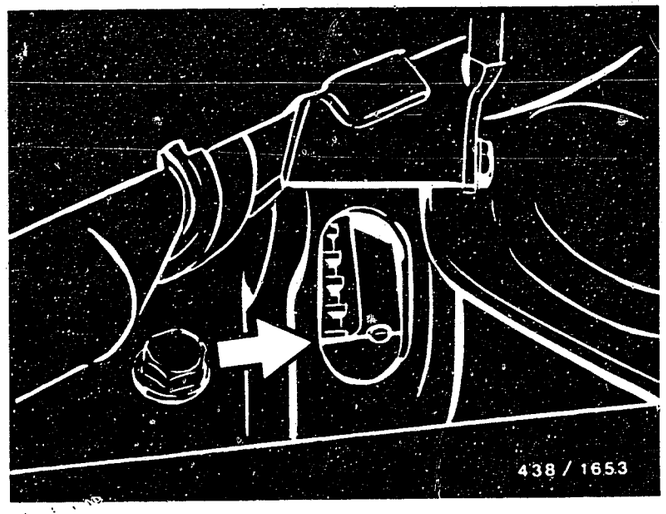
Adjustment O.K.?

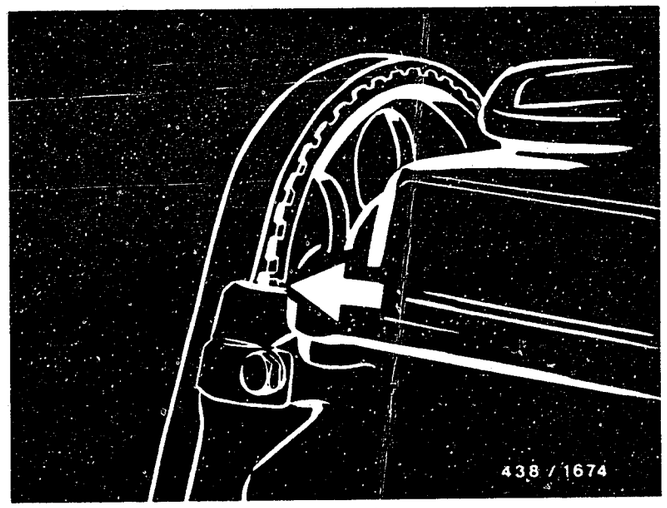
N> Adjust ignition distributor.

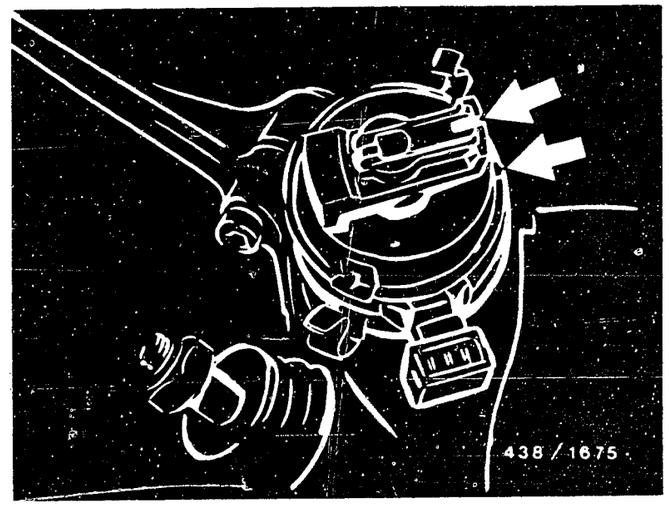
Y

V

Return to trouble-shooting chart B03







TROUBLE-SHOOTING PROGRAM (19)

TESTING BASIC IGNITION SETTING.

* Connect motortester in accordance with operating instructions.

* Engine at operating temperature.

* A/C switched off.

* Remove cap from gear housing (for ignition mark).

* Run engine at idle and check firing point.

 Set values: see vehicle-specific brief instructions.

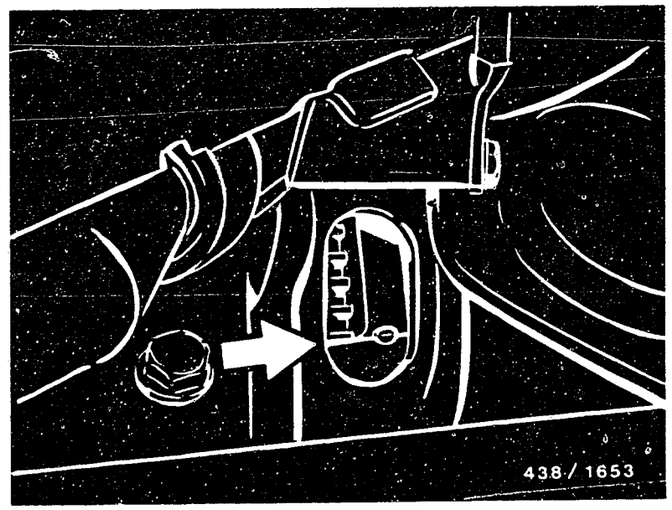
O.K.?

Finally renew cap for gear housing.

N>

Turn ignition distributor until setting is attained.

Finally renew cap for gear housing.



Return to trouble-shooting chart B03

TROUBLE-SHOOTING PROGRAM (20)

TESTING IDLE ADJUSTMENT.

Test prerequisites:

* Engine oil temperature min. 80° C.

* Electrical loads switched off (cooling fan must not run during testing/adjustment).

* A/C switched off.

* Pressure gauge KDJE-P 100 not connected.

* No exhaust system leaks.

Continued on next picture page

Test procedure:

Connect ammeter (motortester or multimeter) with test lead KDZS 0004 and KDUM 0008 to KE-pressure actuator of fuel distributor (top picture).

Tightly connect exhaust sampling hose of exhaust-gas analyzer to CO-measuring pipe.

Run engine at idle speed.

Idle-speed set value: see vehicle-specific brief instructions.

Note: speed cannot be adjusted; automatically regulated.

Set value for CO-content: see vehicle-specific brief instructions.

Fluctuating pressure-actuator control current (lambda closed-loop control in operation).

Set value: see vehicle-specific brief instructions.

Are both set values obtained?

N>

Idle adjustment:

* Pull cap off activated-carbon canister.

* Detach crankcase breather hose at cylinder head cover and seal it tight.

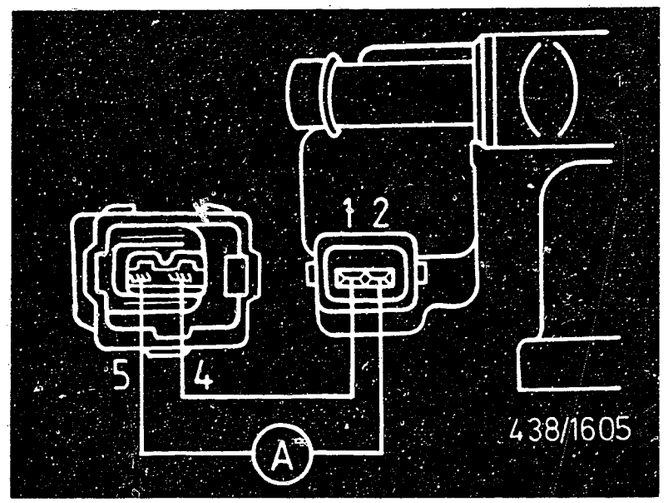
* Detach crankcase breather hose at breather housing (on engine block).

* Remove CO anti-tamper safeguard (plug) at KE-air flow sensor with special tool kit (e.g. Hazet tool kit 4521/7).

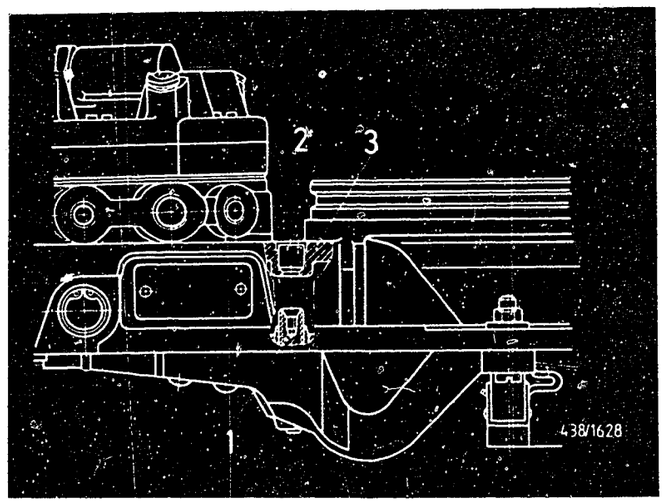
Start engine and run at idle. Adjust pressure-actuator control current if necessary by adjusting the idle-mixture-adjusting screw in the mixture-control unit (bottom picture).

Anti-clockwise direction: increased current
Clockwise direction: reduced current

Note: the CO value is a reference value and results automatically given closed-loop control and a correctly set current value. There is no possibility of adjustment.



1 = Idle-mixture-adjusting screw
2 = Plug
3 = KE-air-flow sensor



Continued on next picture page

TROUBLE-SHOOTING PROGRAM (20) CONTINUED (2)

Test idle speed control – idle actuator for freedom of movement:

Allow engine at operating temperature to run at idle speed.

Increase speed several times and check whether the measured idle speed is obtained again in each case.

O.K.?

N>

Tap several times against idle actuator with screwdriver.
Engine speed changes: idle actuator is not moving freely.
Replace idle actuator.

Y

Continued on next picture page

L27 — <⟹>

L28 — <⟹>

TROUBLE-SHOOTING PROGRAM (20) CONTINUED (3)

Engine-speed increase - air conditioner (if air conditioner fitted):

Run engine at operating temperature at idle speed. Measure engine speed.

Switch on air conditioner.

Switching on the air conditioner must cause the engine speed to increase by 70 min $^{-1}$.

O.K.?

N>

Switch off engine and detach control-unit connector.

Connect voltmeter to control-unit connector, term. 32(+) and term. 18 (-).

Switch on ignition and air conditioner and measure voltage.

Set value: battery voltage.

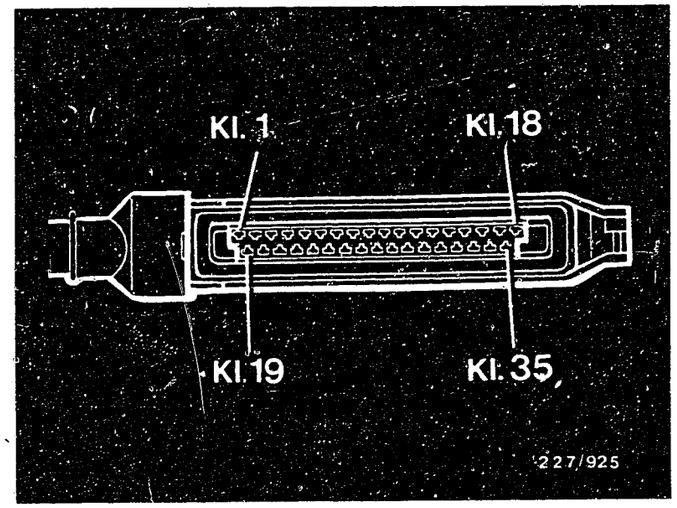
Eliminate any open-circuit in lead from term. 32 to air-conditioner controls.

Switch off ignition.

Use ohmmeter to perform continuity test on lead from control-unit connector, term. 33 to A/C compressor +.

Set value: approx. 0 Ω

Eliminate any open-circuit.



Continued on next picture page

TROUBLE-SHOOTING PROGRAM (20) CONTINUED (4)

Checking and adjusting the potentiometer on the air-flow sensor:

Note: This test step is necessary in the case of poor idle/part-load performance.

Disconnect plug from potentiometer. Using auxiliary leads KDZS 0004 and KDUM 0008, reconnect all three contacts of the plug to the potentiometer, so that connection of a voltmeter is possible (note pin assignment in picture).

Operate warmed-up engine at idle speed. Connect voltmeter to term. 1 (+) and 3 (-) and measure supply voltage to potentiometer.

Set value: see vehicle-specific brief instructions.

Note down measured value.

Set value obtained?

N>

* No voltage reading:

 Stop engine and disconnect plug from control unit.

 Using ohmmeter, check the following leads between both plugs for:

 Term. 23, 26 and 35 open circuit.
 Set value: approx. 0 Ω .

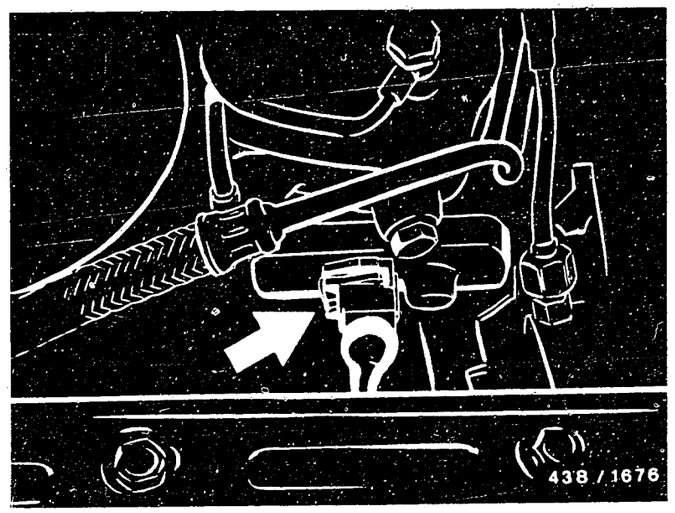
 Term. 23 and 26 short circuit to ground.
 Set value: infinity Ω .

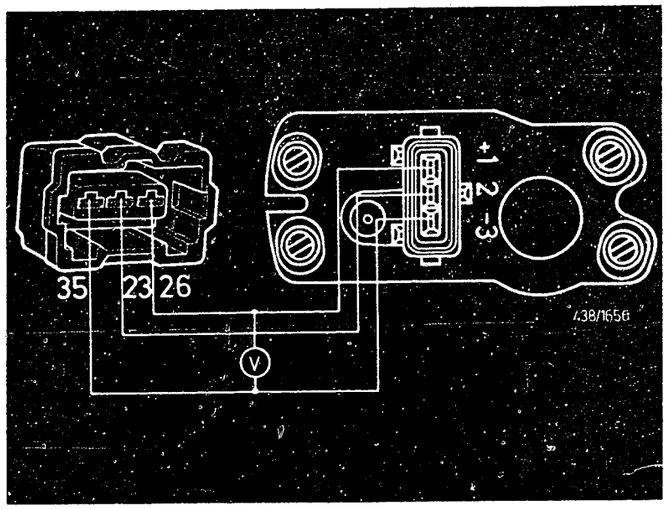
 Term. 23 and 35 short circuit to positive.
 Set value: infinity Ω .

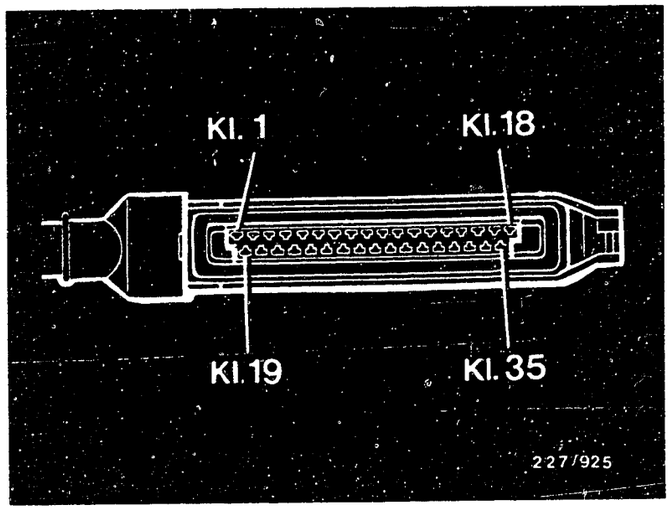
 Eliminate any line faults. If there is no line fault, control unit defective. Replace control unit.

* Voltage reading not within tolerance: control unit defective. Replace control unit.

Continued on next picture page







TROUBLE-SHOOTING PROGRAM (20) CONTINUED (5)

Connect voltmeter at term. 2 (+) and 3 (–) of potentiometer and set to 1.5 V measuring range.

Check potentiometer signal at idle speed.

Determine the set value from the curve contained in the test specifications as a function of the previously measured supply voltage.

Set value: see vehicle-specific brief instructions.

Set value obtained?

N>

* No voltage signal:

 Potentiometer defective. Replace complete air-flow sensor.

 Important: potentiometer cannot be changed with KE-Motronic. The four fastening screws must not be loosened.

* Voltage signal not within tolerance:

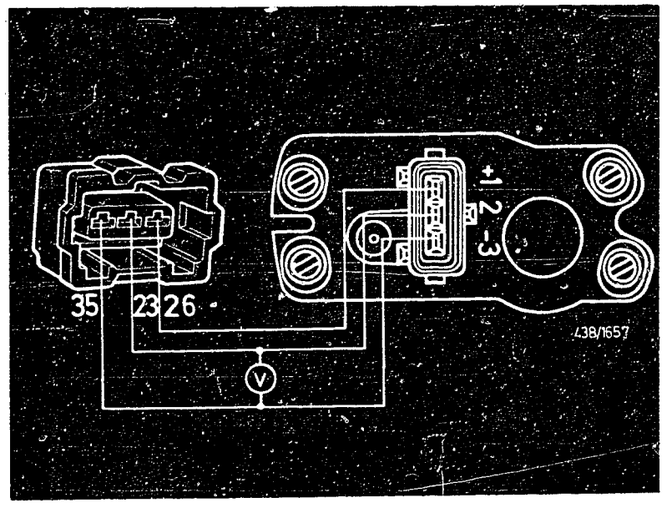
 In the event of slight deviation, adjustment can be made by way of the small trimming potentiometer (to the left of the connector). To do so, remove potting compound and adjust trimming potentiometer carefully, sensitively and with a very small screwdriver. Finally secure trimming potentiometer with black sealing compound (e. g. Teroson).

 If adjustment is not possible, replace complete air-flow sensor.

Y

Return to trouble-shooting chart B03

Continued on next picture page



Note the following when replacing the air-flow sensor:

Before removing the fuel distributor, thoroughly clean it in the area of all fuel connections.

Install the air-flow sensor with new flange seal (Audi service part), without sealing compound.

Replace seal between air-flow sensor and fuel distributor.

Tightening torques: Air-flow sensor fastening screw 9...10 Nm, fuel-distributor fastening screws 3,2...3.8 Nm.

Free travel of air-flow sensor plate after mounting of fuel distributor and after any correction to the idle adjustment: "can be felt" to 2 mm at center of sensor plate.

V

Return to trouble-shooting chart B03

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